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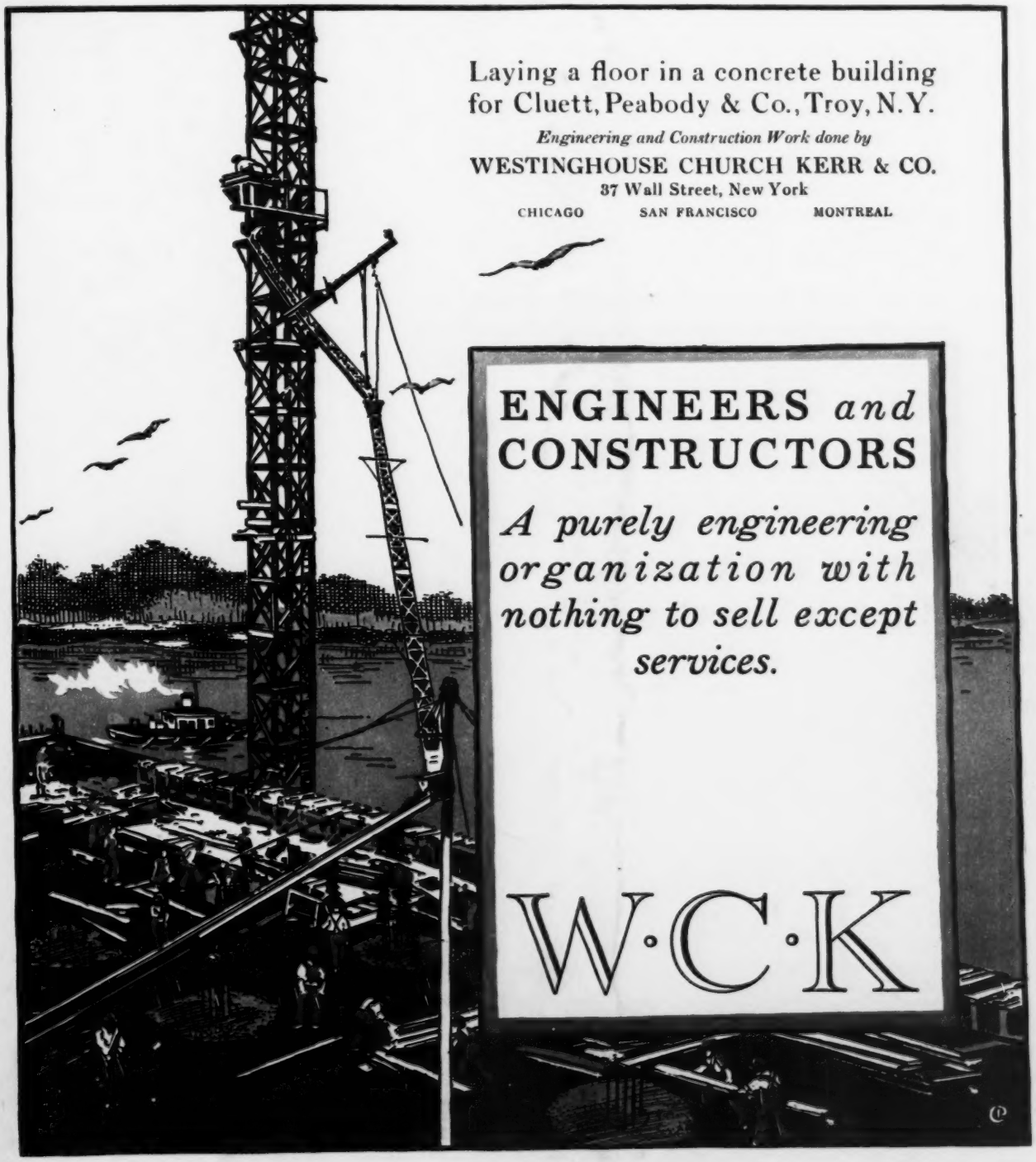
Laying a floor in a concrete building
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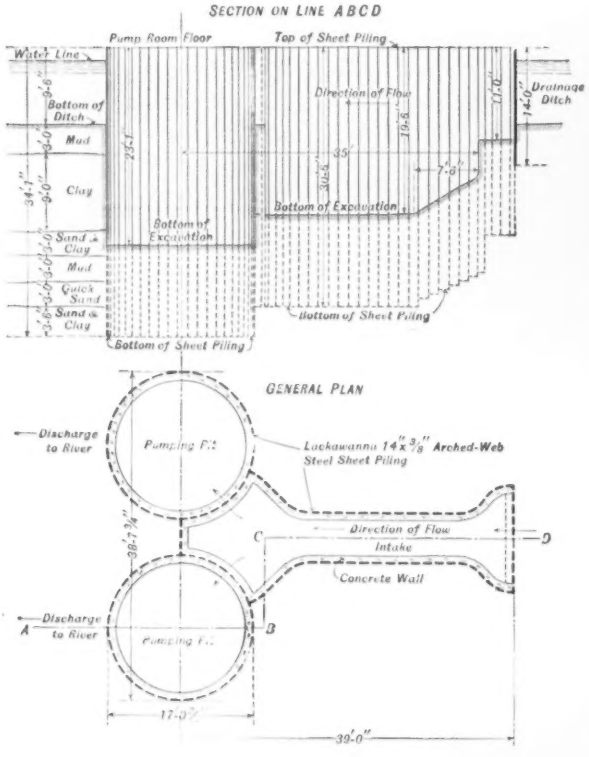
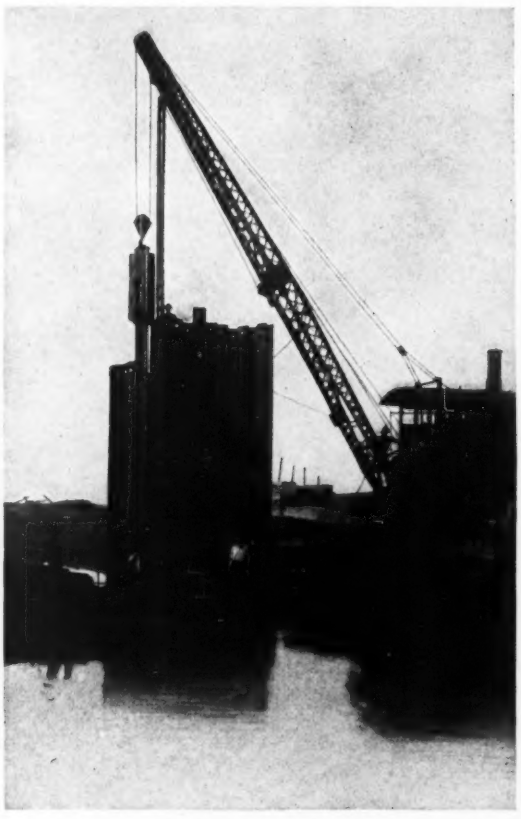
The Lackawanna Steel Sheet Piling Drainage Pits of the Texas Co., Port Arthur, Texas

This is a good design where land areas are low and require drainage by ditches to levels below surrounding water. The steel sheet piling was driven into soils thoroughly impregnated with water, excavated and then lined with concrete to form sumps or pumping pits. The pumps were housed in building constructed on top of the steel sheet piling walls and directly over pits.





The photo shows the first pit (under platform) driven and steel sheet piling being assembled for the second. The complete assembling of such a cylindrical steel sheet piling enclosure, permits of driving each sheet piling section a little at a time and avoids all possible annoyance in making closures.

Ask for our book "Lackawanna Steel Sheet Piling" and if you want it, the free advice of our Steel Sheet Piling Engineers.

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Wabash Grade Elimination in Fort Wayne

The Wabash R.R. originally ran at grade through Fort Wayne, Ind. Four or five years ago the three tracks were raised on a fill, and a fourth track added. Over streets the tracks were carried on pile bents. The construction of permanent crossings began in 1914, and is being carried on at the present time by the Carmichael-Cryder Co.; W. R. Carmichael, Superintendent on the job. Traffic on the railway has not been interrupted. A typical crossing on this elimination, and one of unusual interest, is that at Taylor St., shown under construction in the accompanying views. The three concrete bents shown were built in 1914 to 1915; the abutments were started in the spring of 1916. The soil is clay, but the footing excavations were in fill.

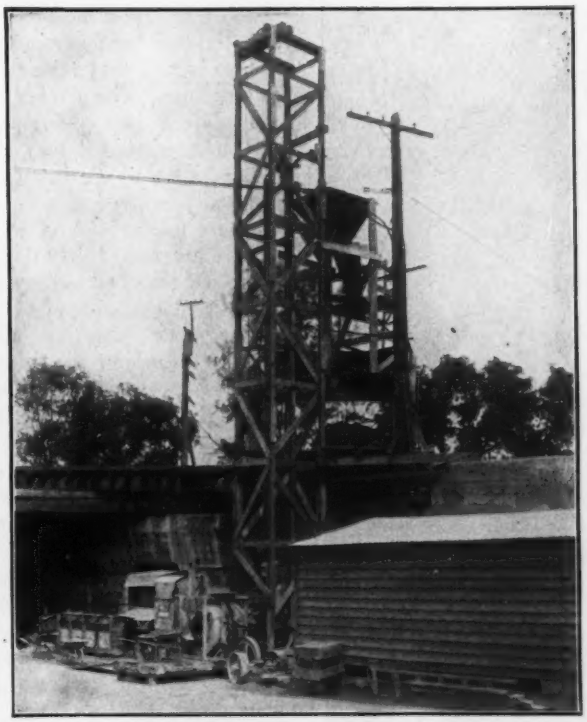


FIG. 1. CONCRETING PLANT NEAR NORTH ABUTMENT

The mixer plant is shown in Fig. 1. Concrete for the footings was wheeled in hand carts from mixer to site. The piers were concreted from the top of the temporary crossing. A concreting tower was erected at the same time as the forms for the north abutment and adjacent, as shown (Fig. 2). This abutment was placed by a chute from the tower. The footing for the south abutment was placed using hand carts wheeled from the mixer. The abutment itself was concreted by use of these same carts running on a plankway on the trestle deck. Gravel for the concrete was bought from the Carmichael Gravel Co., Attica, and shipped to the job in hopper-bottom cars. At the site the cars were dumped through the tracks into a storage pile between

FIG. 2. CONCRETE FOUNDATIONS REPLACE PILE BENTS AT WABASH CROSSINGS IN FORT WAYNE, IND.

two piers. Sand was dumped in the same manner but on the west side (shown in Fig. 1) of the work, the gravel being on the east. The sand and gravel were transported from storage piles to mixer by means of wheelbarrows. The cement was stored in a shanty adjacent to the tower. An electric hoist was used in the tower.

The deck of the crossing was constructed of reinforced-concrete slabs, 20 ft. long by 6½ ft. wide and 3 ft. deep.

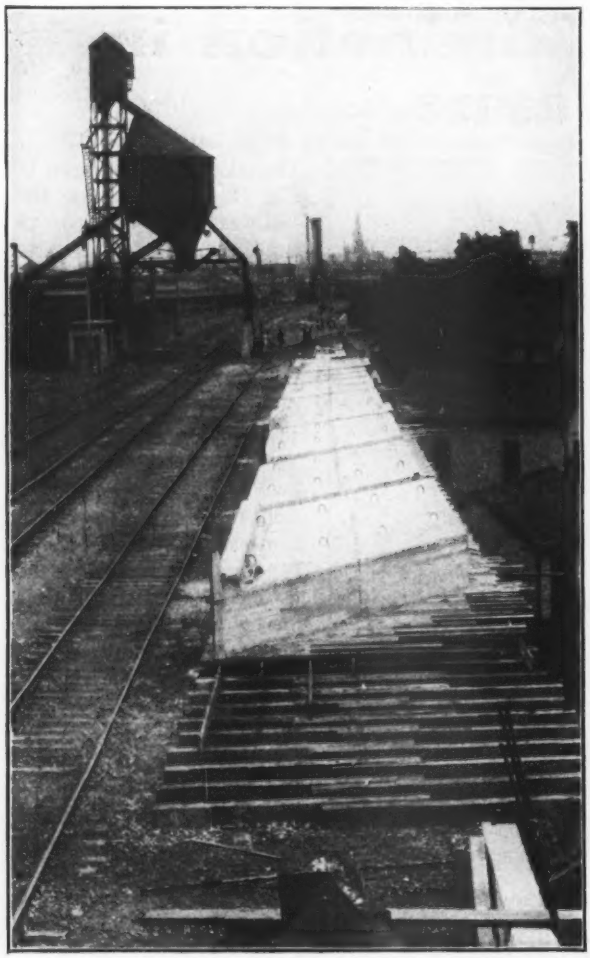


FIG. 3. LARGE DECK SLABS CAST ON EMBANKMENT ADJACENT TO CROSSING

These slabs were cast on the fill adjacent to the crossing, as shown in Fig. 3. They were then allowed to set for 28 days, when they were placed in permanent position by a wrecking crane. Hydrated lime was used in the concrete, and Mr. Carmichael states that it "helped immensely in working the concrete, making the 1:3:6 mix handle as easily as a 1:2:4."

Ecuador Uses More American Cement now than formerly owing to the construction of culverts and foundations for new railway bridges, the work on the sanitation of Guayaquil, and a recent municipal building ordinance requiring concrete foundations for all new buildings. The consul general, Frederick W. Goding, states that although the cement imported at present is almost exclusively American, due to war conditions, there are serious problems relative to its sale after the war that ought to be solved. American cement barrels are not so strongly made as those of European competitors. Empty barrels of German and British origin in good condition bring about 19c. each, whereas the American barrel never sells for more than 14c. Mr. Goding believes steel barrels with wood heads to be the true solution of this question.

Reinforced-Concrete Ore Dock at Ashland, Wis.

By W. E. King*

Among the notable pieces of reinforced-concrete construction to be erected this year is the ore dock now being built by the Minneapolis, St. Paul & Sault Ste. Marie R.R. at Ashland, Wis. It is 80 ft. high above water level, 1,132 ft. long and is to be built almost entirely of reinforced concrete. This type of dock, for the transfer of iron ore from trains to vessels, has been developed largely on the Great Lakes, and a general description of the docks previously constructed will show the unique features of the Ashland dock.

Stated briefly, a modern ore dock is generally a four-track elevated trestle from 60 to 80 ft. high above water level, so located that vessels may be loaded at two sides of the structure. The arrangement is such that ore may be dumped from bottom-dump cars to bins situated under the tracks, whence it may be spouted by gravity to the holds of vessels. To this end the floors of the ore bins are usually inclined at a slope of about 45° and surfaced with hard maple.

There are some thirty docks of this type on the Great Lakes. Of these, all but seven are of timber construction, the earlier docks being of smaller capacity and less height. Timber construction has the advantage of a smaller first cost, but because of the extremely heavy loads to be carried the depreciation of a timber dock is very rapid, the average life being from five to ten years. To be added to the expense of repairs are the extremely high insurance rates charged and the risk of the loss of business and profits sure to accrue in the event of fire.

These considerations have more recently led to the construction of semifireproof docks, of which there are seven now in existence. Four of these docks—two at Duluth, Minn., and two at Two Harbors, Minn.—are of steel-frame construction. Two docks at Allouez Bay, Superior, Wis., are built of concrete up to the underside of the bins, and of structural steel, wood and concrete above. The upper decks, platforms and bin floors are generally of wood, although two of these docks have concrete upper decks and one has concrete bin floors supported by a steel frame. One dock at Marquette, Mich., is of concrete reinforced with a steel frame.

In the design of the Ashland dock a radical change in the materials of construction was found to be economical because of present market conditions. Structural steel, which forms a large part of the semifireproof docks previously built, has increased in price to an almost prohibitive figure. Reinforced concrete, on the other hand, has not increased in nearly the same proportion.

This relative change in the price of materials renders a concrete dock more economical in spite of the difficulties inherent in the material. These difficulties are of two kinds—those of design and those of construction. The excessive loads to be carried, the problem of temperature stresses and of the unreliability of the material used are the most serious considerations of design. The expense and necessity of expansion joints are coniderably greater for a concrete than for a steel dock.

The peculiar difficulties of construction lie in the complicated formwork, the intricate reinforcing to be placed,

*Toltz Engineering Co., Pioneer Building, St. Paul, Minn.

the extreme concrete pressures to be encountered and in the short working season during which concrete can be safely poured in such an exposed position.

All these difficulties are susceptible of a monetary valuation; and when so considered, a reinforced-concrete dock is considerably cheaper than any other type of fireproof ore dock. It is also to be expected that the depreciation and cost of maintenance will be considerably less for a concrete than for a steel-frame dock.

Design of Ashland Dock

Reference to Fig. 1 will show that the Ashland structure consists of 160 lin.ft. of concrete approach trestle, 900 lin.ft. of ore dock proper and 72 lin.ft. of fender dock. This total length is separated by nine expansion joints into lengths of about 120 ft., provision being made for 1 in. of expansion at each joint. The dock contains 150 bins, having a capacity of 9 cars each, making a total capacity of nearly 60,000 tons of ore.

The total load of the structure is carried on piles from 40 to 60 ft. long, driven into sand. In order to provide lateral stability these piles are surrounded by a timber crib filled with coarse sand. Crib timber is to be native hemlock, except the long cross-timbers, which are Oregon fir.

The intention is to build these cribs in suitable lengths and float them to the point of final location as soon as the trench for the slip, 25 ft. in depth, has been completed. They will then be sunk by filling certain compartments with sand. After the sinking of the crib the piling will be driven and cut off and the crib then completely filled with sand.

The construction of the crib is shown in Fig. 3. It is to be built of 12x12- and 10x12-in. timbers, securely drift-bolted together. The crosswall timbers are to be dovetailed into the front-wall timbers, in addition to the drift-bolting. The specifications call for the cribs to be made permanently sand-tight, by means of 1x4-in. battens wherever necessary.

The concrete substructure up to the top of the pyramidal column bases is to be built of 1:3:5 concrete. It is quite heavily reinforced to distribute contraction stresses and stresses due to shocks from vessels striking the concrete fender, which is built as a part of the substructure. Attention is called to the convex cross-section of the fender, which thus determines the exact elevation at which the shocks from the vessel will be received by the dock. The fender is protected by two lines of steel beams bedded into the concrete.

The columns of 1:2:4 concrete spaced 12 ft. on centers longitudinally by 42 ft. 3 in. across the dock, are figured as unreinforced-concrete piers. Such reinforcing as is provided is designed to distribute bending stresses due to shocks from vessels, contraction of concrete and wind-load.

Two lines of 18x24-in. concrete struts running lengthwise of the dock between columns provide lateral stiffness for the columns in that direction. At bays midway between expansion joints the space between two columns is filled in with a 16-in. wall, properly reinforced to carry traction stresses from the structure above to the foundations.

Details of the Bin Walls and Floors

Extending across the dock and between columns are the 16-in. walls of the bins. These walls serve primarily as arch ribs carrying the loads from the trains, the ore in the bins and the dead-load of the structure directly to the columns. Arch computations have been based upon an elastic arch, due consideration being given to the deflection of the supporting columns. Temperature stresses in the arch have been neglected. The thrust of the arch is to be carried by a heavily reinforced concrete tie 16x30 in., running between the columns at the springing line of the arch.

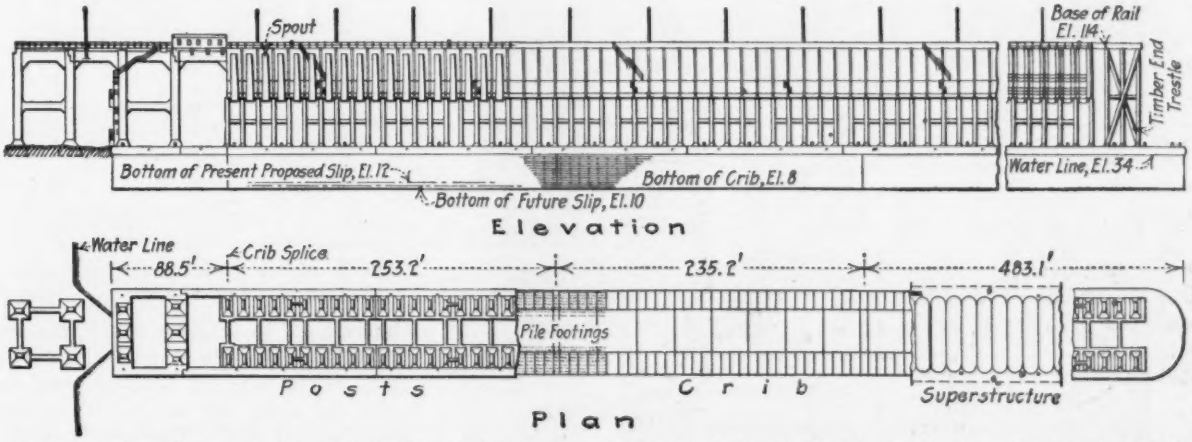


FIG. 1. GENERAL PLAN AND ELEVATION OF NEW ORE DOCK FOR MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE R.R. AT ASHLAND, WIS.

In addition to the arch function these crosswalls serve as retaining walls to take the thrust of the ore when a single bin is filled, the adjacent bins being empty. These walls also serve as columns to carry the weight of the trains from the deck above to the columns below. They are so designed that the compressive stress due to bending acts at right angles to the compressive stress due to column action. This permits the use of much less reinforcing than would be necessary with the usual design where bending and direct stresses act in the same direction.

The inclined bin floors, carrying a load of over 5,000 lb. per sq.ft., span directly between the bin walls, which are 12 ft. c. to c. The floors are 18 in. thick at the lower ends and taper to 12 in. at the upper ends. The usual maple wearing surface has been omitted from these floors. The upper surface of the concrete is to be made as

smooth as possible by the use of good form lumber and well-tamped concrete. Rough places are to be chipped smooth and filled with cement grout. All corners in the bins are to be filled out with concrete fillets, thus doing away with all woodwork in the construction of the bins. The circular front walls for the bins, which are the characteristic feature of the Toltz ore-dock patents and which in previous designs have been made of steel plates, are to be built of concrete. Because of their circular shape the principal stresses from the thrust of the ore are tensile stresses, which are taken care of by running the band rods well back into the bin walls. The concrete structure up to the under side of the steel track stringers is designed to be structurally complete without dependence upon any of the structural-steel parts. The concrete is to be poured in three separate operations. The foundations up to the top of the column bases will be poured first, then the columns up to the under side of the bin floor. The concrete of the bins is to be

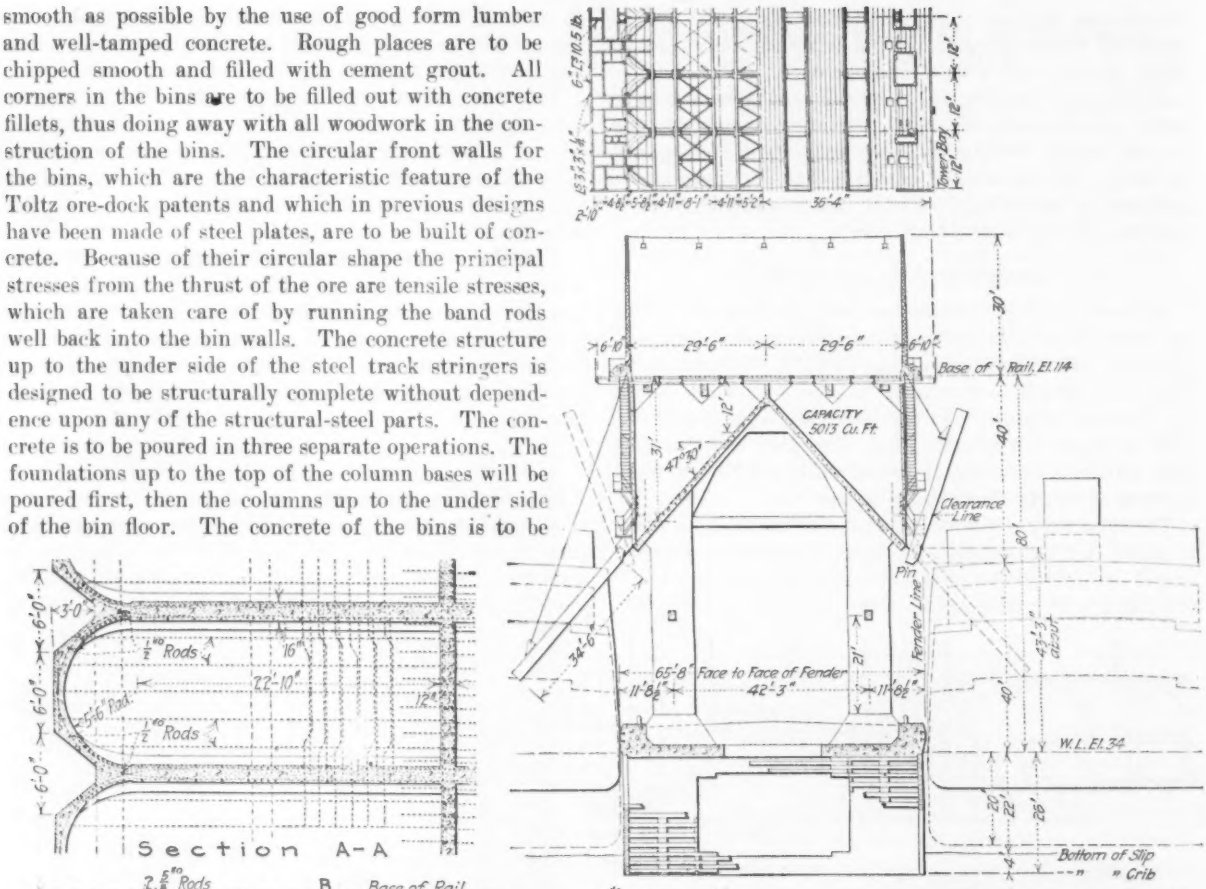


FIG. 2. DETAILS OF SUPERSTRUCTURE OF MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE R.R. DOCK

FIG. 3. SECTION THROUGH BINS AND PART PLAN

poured at one continuous operation, one section of dock between expansion joints being carried up simultaneously.

Forms are being designed for a fluid pressure of 600 lb. per sq.ft., which, according to Prof. Adolph Meyer's experiments (see "Journal" of Association of Engineers' Societies, p. 199, Vol. 50), corresponds to a rate of pouring of not to exceed 3 vertical feet per hour at a temperature of 45° F. Forms for 360 lin.ft. of dock superstructure are to be made at the mill in suitable sections for handling, according to detail plans now being prepared in much the same way as shop drawings for structural steel. The large number of parts that are exact duplicates makes this unusual procedure economical. Because of the fact that the floor of the upper deck must be placed in the winter time, thus making the pouring of concrete slabs very expensive, it has been decided to build the upper deck of fir planking laid on steel beams, which form the bracing for the track stringers. All structural steel is arranged to be bolted in place at any time after the completion of the concrete work. The track stringers are made of structural steel, because concrete stringers would take up too much room, thus lessening the storage capacity of the ore bins. The track rails are to be riveted to the track stringers to prevent slipping. Steel doors of the patented Dickerson self-closing type are provided. They are so arranged that a part of a bin of ore may be run and the remainder cut off at will.

The 34-ft. steel chutes are of the type first used on the Great Northern Dock No. 4 at Superior, Wis. Attention is called to the straight sides of these chutes, which form girders not unlike the "pony trusses" of a through high-

way span. They are designed to carry the load resulting from the chutes clogging full of ore weighing 170 lb. per cu.ft. The chutes are not counterweighted, but are raised and lowered by means of electrically operated hoists, located on the upper deck. These hoists are designed to raise or lower each chute in 32 sec. They are arranged in groups of ten, connected with a lineshaft which in turn is geared to a 25-hp. Crocker-Wheeler motor.

The upper deck is lighted by fifteen rows of five incandescent lights each, suspended from wire cables running across the dock between 30-ft. steel poles. The interior of the bins, the door platforms and the dock fender are all well lighted with incandescent lights provided with suitable reflectors.

The dock is to be reached by approximately 1,000 lin.ft. of double-track timber approach trestle. Connecting this timber approach to the dock proper is provided 160 ft. of reinforced-concrete trestle with ballasted deck, arranged to give rigid support for the necessary switches leading to the four tracks of the dock proper. As before stated in the case of the dock, a four-track trestle, 80 ft. high,

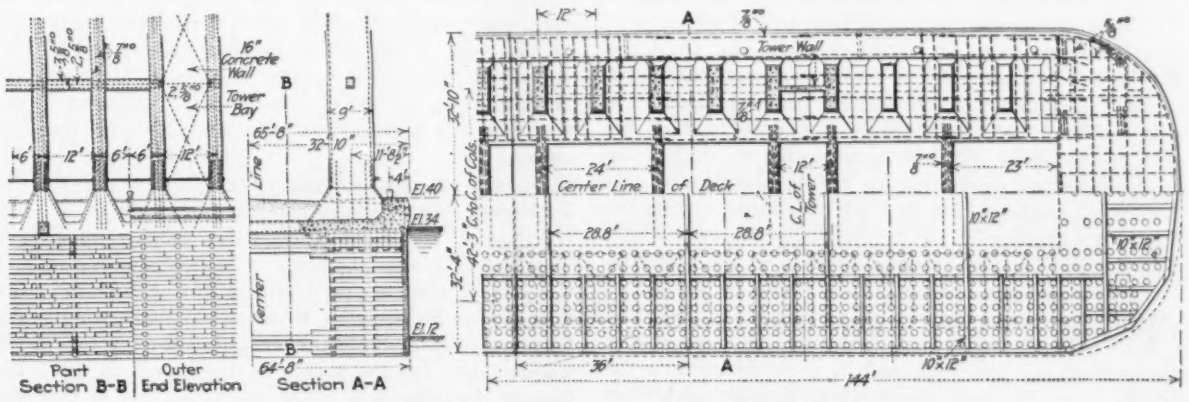


FIG. 4. FOUNDATION DETAILS OF ORE DOCK AT ASHLAND, WIS.

would ordinarily be built of structural steel, but the present market conditions now render reinforced concrete more economical.

The trestle is made up of four 40-ft. spans supported on two two-column bents and two three-column bents. Expansion joints are provided at two points. The foundations are supported on piles and are rigidly fastened together to prevent relative motion between the various piers.

Provision is made at the outer end of the dock for a future extension. To provide for present needs a temporary wooden trestle is to be built. Upon this trestle will rest the bumping posts of the tracks and the signal lights of the dock.

Specifications for Loads and Stresses

The dock is designed according to the following specifications:

1. Upper Deck Floor—Live-load, 125 lb. per sq.ft.
2. Trainloads—Cooper's E-50 engine loading or a loaded ore car weighing 160,000 lb.
3. Allow 25% impact in design of all track stringers and girders.
4. Figure wind loads at 30 lb. per sq.ft. on loaded structure and 50 lb. per sq.ft. on unloaded structure.
5. Weight of ore in bins considered in design estimated at 7 cars of 110,000 lb., 770,000 lb. Bin floors figured to carry this entire weight.
6. Lateral pressure of ore to be figured at $p = 30h$, where p is the horizontal pressure per square foot and h is the depth of ore to the point in question.
7. Bin walls are to be figured as an arch to carry all the loads enumerated except No. 1 and No. 3, which are to be disregarded.
8. Unit stresses in steel and concrete shall be figured according to American Railway Engineering Association specification.
9. Substructure to be figured to carry all the foregoing loads except No. 1, No. 3 and No. 4, but shall be designed to care for the effect of the horizontal wind stresses.

Concrete in the substructure is to be 1:3:5 mix and for the superstructure 1:2:4 mix, using gravel for the aggregate.

The general contractors for the substructure and concrete work are Foley Bros., Peppard & Fulton, of St. Paul, Minn.; for the structural-steel work, the Minneapolis Steel and Machinery Co., of Minneapolis, Minn.; for the hoists, the Clyde Iron Works, of Duluth, Minn.; for the electric wiring, W. I. Gray Co., of Minneapolis, Minn.

The dock was designed by the Toltz Engineering Co., Consulting Engineers, St. Paul, Minn. (of which Max Toltz is the president and mechanical engineer and W. E. King the structural engineer), under patents belonging to Mr. Toltz. All work is being done according to the direction of C. N. Kalk, Chief Engineer for the Minneapolis, St. Paul & Sault Ste. Marie R.R.

Motor Vehicles in the United States have increased fifty-fold in the past ten years. Statistics just made public by the Office of Public Roads and Rural Engineering, based on state registration of motor vehicles, show that while there were only 48,000 vehicles registered in 1906 there were 2,445,664 registered in 1915. In view of the well-known heavy production of motor-car factories during the present year, it is probable that there are nearly 3,000,000 motor vehicles in service in the United States at the present time. In 1905 little had been done in the systematic registration and licensing of motor vehicles, and the total revenue collected by the various states amounted to only $62,500. In 1915, the state revenues from motor-vehicle licenses, permits to chauffeurs, dealers, etc., amounted to $18,245,000. Of this total revenue, fully 90% was applied to road work and a little over 70% was expended under the control of the state highway departments. The annual registration of motor vehicles is required in nearly all the states. In South Carolina, Texas and the District of Columbia, however, a car is registered once for all. In Mississippi, one registration by the state is sufficient, but an annual county license is also required. In Minnesota, motor vehicles are registered for three-year periods. The proportion of motor cars to population varies widely. Iowa has one for every 16 persons while Alabama has only one for every 200. The license fees in many states are still very low. In only 15 states is the average gross return from motor-car registration over $10, and many large states receive less than $5 per car. Vermont's average return from motor-car licenses is $18.10.

Compensation in Kind Involved in Hartford Water Case

By Caleb Mills Saville*

SYNOPSIS—United States Supreme Court holds private property can be condemned for compensation purposes in Hartford water-rights case. Compensation in kind is a public use.

For many years the proposition to replace water diverted from a stream by other water stored in reservoirs during periods of flood flow has been a difficult question in this country, and until recently there seemed little hope of obtaining favorable consideration in law for such a plan.

By mutual agreement this method has been employed in a few cases, but the broad principle of compensation in kind has never been established in the United States. In England compensation in kind in lieu of money damages has been practiced for many years, and an Act of Parliament or a commission sitting as a court may determine the amount of compensating water which must be provided. In the United States the usual method has been the payment of money damages, on account of the legal difficulties pertaining to the employment of the method of compensation in kind. Principally, this has been due to rulings of the United States Supreme Court that the just compensation guaranteed by the Constitution in the case of property taken by process of law can be provided only by payment of money.

With changing conditions, a new era in water-supply development has appeared, and by a recent decision the United States Supreme Court seems to have established a principle that will greatly smooth the way for the substitution of compensation in kind in place of money damages in cases of necessary diversion of water.

The United States Supreme Court (Manchester vs. Board of Water Commissioners of the City of Hartford, Conn., 863, 864 and 865, Supreme Court of the United States, October Term, 1915) has recently handed down a ruling relative to condemnation of property for compensation purposes that is most important in its present bearing and may be far-reaching in its future application. This ruling upholds the decision of the Supreme Court of Errors of Connecticut (Water Commissioners vs. Manchester, 87 Conn., 206, and 89 Conn., 677) and affirms that the condemnation of land for a compensating reservoir is a "taking for a public use" within the meaning of that expression in the first article of the Constitution of the State of Connecticut and is not contrary to the provisions of the 14th Amendment of the Constitution of the United States.

In 1909 the City of Hartford, Conn., petitioned the General Assembly of the state for authority to appropriate the waters of the Nepaug River and Phelps Brook and to construct an impounding reservoir for the purpose of obtaining an additional supply of water. These streams are tributary to the Farmington River and enter it in the vicinity of Collinsville, a manufacturing village situated in the north central part of Connecticut, about 37 mi. above the junction of the Farmington and Connecticut Rivers. The Farmington River is a rather fully utilized stream with ten principal power developments between the point of diversion and the confluence with the Connecticut. The total fall in this length is said to be about 168 ft. and the approximate amount of power developed or available in the neighborhood of 11,600 hp.

Because of the claim of the power owners along the river that the taking of the Nepaug River and Phelps Brook would deplete the flow in the main stream to such an extent as to occasion irreparable damage to their interests and those of the villages situated below the point of diversion, the petition of the city to take the water was denied by the General Assembly.

The necessity of the City of Hartford to obtain an additional supply of water, however, was well recognized, and as most of the power interests were owned or controlled by very public-spirited citizens of Hartford, the matter of an amicable adjustment of differences was worked out in a manner satisfactory to the principal mill owners.

In brief, the final solution of the problem provided for a compensating reservoir, so-called, located on a large tributary of the Farmington River, farther up stream. This reservoir would be filled in times of excess flow, and was of such size that its discharge during periods of low flow in the Farmington River would make up the deficiency caused by the diversion and be used in lieu of the waters taken for the supply of the city. In 1911 the General Assembly was again petitioned, and at this session an act was passed authorizing the taking of the Nepaug River and Phelps Brook for the supply of Hartford and also including authority to build a compensating reservoir.

ford and also including authority to build a compensating General Assembly, the City of Hartford proceeded to acquire the land necessary for the purpose. Most of this was purchased at figures considerably in excess of assessed values, or at those estimated by impartial appraisers, and the Water Board was not at all niggardly in its settlements, recognizing the hardship to land owners on the one hand and the expense of litigation on the other.

The owners of two large and important properties at first would set no price, though later on they named figures that were absurd even in consideration of other settlements. Subsequently, one of these settled with the board for a large sum. The other carried his case through the state courts and up to the United States Supreme Court. This court approved the opinion of the state courts and gave final judgment in favor of the city. The matter then came back to a committee appointed by the state court for assessment of damages and is now in its final stage before that body.

The first legal move in this case was made Aug. 12, 1912, when a copy of the petition of the City of Hartford for the appointment of appraisers was served on the respondents and final judgment was given on Apr. 17, 1916, by the United States Supreme Court.

*Chief Engineer, Hartford Water-Works, Hartford, Conn.

The respondents demurred to the appointment of appraisers on the following grounds: That the water of the compensating reservoir was not for the use of the City of Hartford; that the city was not required but simply authorized to return water to the river; that the maintenance of the flow of the river was not a public use but a private benefit to lower riparian owners; that the real purpose of the compensating reservoir was to enable the City of Hartford to trade off the impounded water in lieu of paying money damages; that such a purpose was uncertain of accomplishment because lower riparian owners would be legally entitled to take their compensation in money; that the resolution, in so far as it purported to take the respondent's land for the purposes of a compensating reservoir, was in violation of the constitutions of Connecticut and of the United States.

This demurrer was sustained by the judge of the Superior Court, but on appeal the Supreme Court of Errors of the state overruled the decision, holding that the taking was for a public use and not contrary to the constitution of the state or of the United States (87 Conn., 193 et seq.) and remanded the case to the Superior Court to be proceeded with according to law. Under this ruling appraisers were appointed to establish the value of the land. Appeal was again made to the Supreme Court on points of law. This appeal was not sustained. Application was then made to the Supreme Court of the United States for a writ of *supersedeas*, and it was ordered issued by Associate Justice Charles E. Hughes, Feb. 10, 1916, three and a half years after proceedings were begun.

In sustaining the appeal from the judgment in the respondent's original demurrer, after disposing of other disputed points, the court took up the principal question as to whether the maintenance and regulation of the flow in the Farmington River was or was not a public use, either in itself or in connection with and by way of compensation for the diversion of a part of the flow of the river to another watershed, for the use of the City of Hartford. Especial notice was taken by the court of the importance of this river, the populous manufacturing towns and cities built up around its water powers, and its capability for use in other ways for industrial, commercial and municipal purposes, and that its floods and droughts must annually affect, directly or indirectly, many persons other than the riparian owners along its banks.

The principle was brought out that "public use" means public usefulness, utility or advantage, or what is productive of general benefit, and in a previous case (Olmstead vs. Camp, 33 Conn., 532, decided in 1866) the court said: "It would be difficult to conceive of a greater public benefit than garnering up the waste waters of innumerable streams and rivers and ponds and lakes and compelling them with a gigantic energy to turn machinery and drive mills and thereby build up cities and villages and extend the business, the wealth, the population and the prosperity of the state," and (87 Conn., 206) "It lies within the constitutional power of the General Assembly to declare whether by general flowage acts or by special charter, under what circumstances the right of eminent domain may be employed to that end."

In sustaining the appeal of the petitioners the Supreme Court of Connecticut said (87 Conn., 209):

> We must recognize that the problem of securing sufficient and suitable water-supplies for our larger cities is an increasingly difficult one; that in reaching beyond its immediate watershed a city encounters the opposition of localities seeking to retain their own water courses for their own benefit; that our New England streams no longer possess their former constancy of flow; and that the greatest demand on a municipal water-supply comes at the very time when the natural flow of the stream is likely to be lowest. A separate storage reservoir to impound freshet water and return it to the stream in times of low water may therefore be a logical and consistent engineering factor in a plan for improving a municipal water-supply as well as an instrumentality for conserving the flow of the stream.

What Constitutes Public Use

What constitutes a "public use" was the single Federal question involved. From the nature of the case this can be neither definite nor fixed, but must depend upon that which the public necessity, convenience or the welfare of society at a particular time may demand. To quote again:

> What is public use? Our historical research discloses the meaning of the term "public use" to be one of constant growth. As society advances, its demands upon the individual increase, and each demand is a new use to which the resources of the individual may be devoted (Tuttle vs. Moore, 3 Ind. Ter., 712).
>
> The definition of the term "public use" for which land may be appropriated should comprehend not only all existing public purposes justifying such appropriation, but should anticipate the further exigencies of society, demanding new laws and varied exercise of the protecting and fostering aid to the state (Concord Railroad Co. vs. Greely, 17 N. H., 47).

In the brief for the petitioners the following different classes of "public use" were given:

1. When the United States, a state or a municipal corporation seeks to acquire a parcel of land on which to carry out its proper public functions, or to perform some act directly enhancing the security or health of the community, as taking land for forts, schoolhouses, etc.

2. When the public is supplied with some commodity or convenience, as takings for railroads, water supplies, parks, etc.

3. When individual members of the public are enabled to cultivate their lands or carry on their business to better advantage, as construction of dams, building of levees, swamp and irrigation districts.

The opinion of the Supreme Court of Errors of Connecticut, sustained by that of the Supreme Court of the United States, while not establishing the principle of compensation in kind in lieu of money damages, does sanction the taking of land by eminent domain for the purpose of conserving waste waters and returning them to a stream, and it also holds that such action is for "public use" and not a violation of the Constitution of the State of Connecticut or that of the United States.

The United States Supreme Court affirmed judgment *per curiam* in these cases (Manchester vs. Board of Water Commissioners of Hartford, 863, 864 and 865, October Term, 1915, Apr. 17, 1916), upon authority of several previous cases, the last being that of the Mt. Vernon Cotton Co. vs. Alabama Power Co. (240 U. S., 30, 32). Mr. Justice Holmes, in delivering the opinion, said:

> In the organic relations of modern society it may sometimes be hard to draw the line that is supposed to limit the authority of the legislature to exercise or delegate the power of eminent domain. But to gather the streams and rivers from waste and draw from them energy, and so to save mankind from toil that it can be spared is to supply what, next to intellect, is the very foundation of all our achievements and all our welfare. If that purpose is not public, we should be at a loss to know what it is.

This judgment plainly shows that the right of state legislatures to condemn lands under eminent domain rests on the broad principle of public benefit, irrespective of how few there are who avail themselves of the privilege.

Planning and Organizing for Paving County Roads

SYNOPSIS—Organizing to spend $1,500,000 in paving 166 mi. of county roads within two working seasons. Vermilion County, Illinois, organization and preliminary work are described as examples.

A county votes a $1,500,000 bond issue for paving 166 mi. in a system of main roads serving over 800 sq.mi. of territory. There is the usual objection on the part of some few disgruntled taxpayers, and the legality of the bond issue is in doubt for several months. The courts at length establish the legality of the bonds; meanwhile the public has become urgent in its demand to see the completed roads.

Starting without an engineering department or any engineering employee, other perhaps than a county surveyor, the problem is to plan, organize and start in operation an engineering staff that will have to determine the character and kind of pavements to be built, bearing in mind that all the roads of the predetermined system must be paved from the funds available; prepare detail plans, profiles and specifications, divide the work into convenient contracts, advertise for bids and let contracts, start work on numerous contracts almost simultaneously and keep everything running so smoothly that there will be no extras and so that these 166 mi. of pavement will be practically completed in a minimum of two working seasons—such is a not unusual demand of American communities.

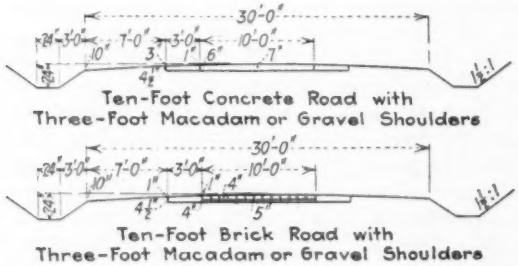


FIG. 1. STANDARD ROAD TYPES ADOPTED BY VERMILION COUNTY, ILLINOIS

To accomplish efficient results with such a lack of preliminary obviously requires some intensive executive work, system and accurate and careful planning. The problem of getting started promptly is often more difficult than that of design and supervision. Therefore, a somewhat detailed description of how the identical conditions described were met in Vermilion County, Illinois, should prove of interest. A general description of the work to be done and the method of financing it was published in *Engineering News*, Dec. 2, 1915, p. 1079.

Preliminary Surveys; Appointment of Engineer

The bond issue of $1,500,000 was voted in November, 1914, and in the spring of 1915 surveys were made by the county surveyor, and the system of roads to be improved was selected. It became evident to the authorities that the work would be of such magnitude as to require the services of a man who was both organizer and engineer, and in the agitation to secure such an expert the general public through the Danville Chamber of Commerce took a leading and insistent part. (Danville, with a population of 30,000, is the principal city and the county seat.) P. C. McArdle, acting chief engineer of the Illinois State Highway Department, was induced to become superintending engineer for the county in August, 1915.

At that time the courts had not passed on the bond issue and an engineering staff could not be organized nor detail work started until that was settled, which was nearly the first of the present year. For his staff the new superintending engineer was fortunate in being able to draw largely upon state highway employees with whose work he was familiar. The previous surveys and plans were first gone over and corrected. The road system to be constructed was divided into nine divisions.

Preparation of Plans and Specifications

Plans, profiles and cross-sections, about 1,800 drawings in all, were prepared in less than two months. These were plotted on Plate A 4x20 profile paper cut into 32-in. lengths. The horizontal scale of both plan and profile is 1 in. = 80 ft.

The scale at right-angles to the center line on the plan is double the longitudinal scale, or 1 in. = 40 ft. The vertical scale of the profile is 1 in. = 4 ft.

The plans show all section corners with references (the monuments are generally in the center of the road), bench-marks, fence lines, shade trees, farm entrances, property owners' names, location of drains and culverts to be built, and other data as necessary. About fifty of these sheets comprise a division. Five blueprint sets of each division were bound in brown paper covers for the use of bidders.

Cross-sections were plotted on sheets of the same cross-section paper, the scale being 1 in. = 4 ft. horizontal, and 1 in. = 4 ft. vertical. Ten cross-sections are plotted on a sheet 42 in. long. Sets of blueprints of these were also bound into books, one book for each division. The use of the same profile paper for plans, profiles and cross-sections materially simplified plotting as well as giving uniform-sized sheets for filing and handling.

The earthwork computations and estimates of each division were made by the engineer who later was to take charge of the construction in that division. His computa-

FIG. 2. BEGINNING THE FIRST MONOLITHIC BRICK PAVEMENT, JUNE 3, 1916

tions when completed were checked by one of the other division engineers. This scheme not only rapidly familiarized the engineers with the work ahead of them but was an additional inducement to thorough work. Each division engineer was given a complete copy of his estimates for use during construction should disputes and differences arise. All estimates were made on standard forms and all computations so far as possible by mechanical devices. The same forms were later given to contractors upon which to submit their bids. The superintending engineer gave a large part of his own time to the preparation of the specifications, proposals, advertisements for bids, etc. His principal assistant and the bridge engineer prepared plans of standard culverts and marshaled data to assist bidders, as will be described later. The other office employees include a draftsman and a clerk.

Helping the Contractors to Make Close Bids

A thorough investigation was made of all the sources of construction material. Available sand and gravel plants in the adjoining part of western Indiana were inspected, listed and plotted on a small map 8½x11 in., which showed fourteen of these material bases as well as paving-brick plants, and all the railroads connecting them and

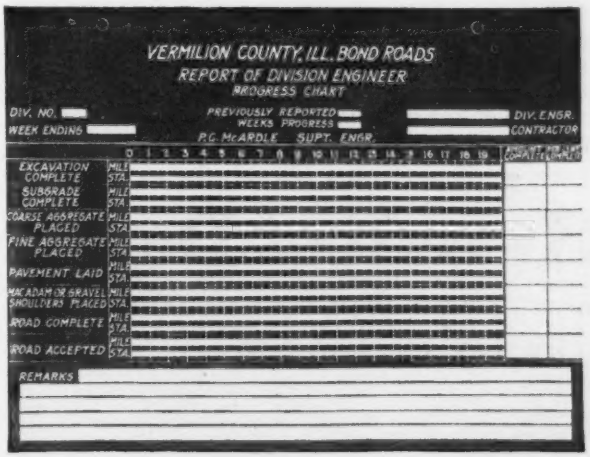


FIG. 3. PROGRESS REPORT BLANK, VERMILION COUNTY ROADS

serving the territory in which the roads were to be built. Blueprints of this were furnished gratis to prospective bidders.

Conferences were held with the operating and engineering officers of the several railway companies whose lines would be used for handling freight. Many special sidings for the use of the highway contractors were agreed upon, some of which were installed wholly at the cost of the railways. It was also desired to secure the coöperation of the railways in eliminating certain grade crossings. The officials of the Chicago & Eastern Illinois R.R. in particular adopted a generous policy of coöperation and assistance.

Special maps 24x20 in. were prepared of each highway division, showing all the roads, railroads and the sidings available for contractors' use. These were furnished gratis to prospective bidders. Small maps were also prepared on which all the important existing road grades were designated, the object being to assist bidders in planning the hauling of materials, or laying out narrow-gage railway lines. Similar plans were prepared showing the location and size (by an index number) of bridges and culverts to be built. To supplement these a small summary sheet was prepared listing all culverts, farm entrances and catchbasins and the quantity of material required for all structures including pavements for each division; so that the bidder had at his finger ends all the data to be gathered from a study of the detail plans and profiles. Bidders were not furnished copies of the highway plans and profiles, but five sets of blueprints of each division were available for inspection at the office of the supervising engineer.

Specifications and Types of Pavement

One set of specifications comprising a book of 24 pp. covered all the work. Proposals were all made on the standard forms furnished by the county. Unit prices were asked on four types of pavement—6-7-in. (6 at the side and 7 in. at the center) concrete, 6-7-in. monolithic brick (4-in. brick with 2-in. concrete base), 7-8-in. monolithic brick and 8-9-in. monolithic brick. All four types were designed 10 ft. wide with 3-ft. gravel or macadam shoulders. Unit prices were asked per square yard for each type of pavement complete, also per square yard for macadam shoulders, gravel shoulders, earth shoulders, concrete gutter and excavation, per cubic yard for reinforced concrete, plain concrete and gravel in the present road (to be paid for by contractor); also for catch-basins and tile drains per linear foot in sizes from 6 to 24 in. A lump sum covering the whole was asked. Bidders could make proposals on one or more of the nine divisions of 19 mi. each, and the proposals could be made on brick or concrete or both.

Brick was the preferred type and the method of choice between the two types after bids had been received was merely to build as much brick pavement as the available funds would permit, placing these pavements on the heaviest-traveled roads, and paving the remainder with concrete.

Copies of the specifications and small maps of the road system with the other data mentioned were mailed to 200 prospective bidders, and the work was advertised in *Engineering News* and other journals.

Large Numbers of Bidders and Low Prices

In response to these advertisements bidders appeared from all over the country and from Canada; in all 135 bids were received. For one division twenty-three bids were received; eight was the least for any one division. The number of firms or individuals bidding was forty. Bids for 6-7-in. concrete ranged from 60c. to $1.13 per sq.yd.; for 6-7-in. monolithic brick from $1.28 to $1.85; for 7-8-in. brick from $1.38 to $1.94, and for 8-9-in. monolithic brick from $1.48 to $2.04 per sq.yd. In every case the bids were received on the basis that the county was to furnish the necessary cement without charge to the contractor.

The average contract price for the 150 mi. of 6-7-in. concrete pavement (Fig. 1) for the nine divisions is 66c. per sq.yd. The average price for the 21¼ mi. of 8-9-in. monolithic brick pavement (Fig. 1) is $1.59. Only one contractor has contracts for more than one division. The great number of reliable bidders made it possible to distribute the contracts and yet keep very close to the minimum bids. The object of this was to engender competi-

tion in speed and workmanship on the different divisions, where work is to be done in every case under almost identical conditions.

The other two types of monolithic pavement, the 6-7-in. and 7-8-in., for which bids were received were approved by Illinois State Highway Department, but the county determined to select the heavier type. Mr. McArdle, however, is confident that these types could have been used with success. An experimental pavement including all three types was described by him in *Engineering News*, Jan. 27, 1916.

Quick Work After Letting

Within a few hours after the bids were opened blueprints giving a tabulation of all bids—a sheet 20x24 in.—and the awards were given to all parties desiring them. The contracts were all awarded on Mar. 17, and in accordance with the specifications work was begun on each division within fifteen days. In the meantime new data sheets were prepared, 7¼x4¼ in., notebook size, giving quantities of all material required, culverts, etc., for each division as well as small scale reproductions of all standards. These were furnished to both field engineers and contractors.

A complete but simple cost-keeping system has been installed. All report blanks are letter-paper size, 8x10 in. There are division engineer's daily reports covering merely labor employed and materials used in different classes of work, daily reports of materials received, weekly reports on materials, labor, and weekly reports on progress of work and payments made, and final report blanks for culverts completed.

The progress report blanks (Fig. 3) are of Mr. McArdle's own design and show at a glance the progress of every stage of the work to within a few feet. Numerous shortcuts and labor-saving devices are in use. For instance, on a small cloth-mounted map of the county road system the superintending engineer has inserted in the proper places the names of all local road officials with whom he must coöperate from time to time. This furnishes a ready reference in time of need without consulting a notebook.

The inspectors report to and are responsible to the division engineers. Motor cars for the division engineers are not furnished by the county, but it is recommended that the division engineers purchase them, in which case the county makes an allowance of $30 per month for their operation. This appears the fairest and most economical solution of the problem, for the engineering staff will go out of existence on the completion of the roads, and the county does not want nine second-hand automobiles to dispose of. Moreover, it is impossible to restrict the use of publicly owned cars to public service.

Construction work is only touched on here as it is intended in a later article to describe how the work on the various divisions is being handled. Practically every contractor is using entirely new equipment. On all but two divisions, contractors are using narrow-gage track with cars and dinkeys for hauling. One is using the track and cars but hauling by teams, while another is using tractors with wagon trains. Altogether the work will furnish some interesting studies in road building and methods of accomplishing results with a short space of time.

Quarries for Kensico Dam

By Wilson Fitch Smith*

SYNOPSIS—Quarries produced 900,000 cu.yd. stone; two-thirds for concrete aggregate. Two types of drills used; spacing and depth of holes. Heavy blasting. Arrangement of crusher plant and cutting yard.

For the construction of the Kensico Dam (see *Engineering News*, Apr. 9 and May 21, 1914, and May 20, 1915) about 900,000 cu.yd. of stone for masonry was required as follows: Concrete aggregate, 635,000 cu.yd.; cyclopean stone, 235,000 cu.yd.; roughly squared stone masonry, 8,000 cu.yd.; dimension stone masonry, 22,000 cu.yd.

Although the land acquired for the reservoir included several possible areas that would yield the necessary stone, the most favorable site for a quarry was a ridge of Yonkers gneiss adjacent to the reservoir lands, about ¾ mi. from the east end of the dam. Being at a somewhat higher elevation than the top of the dam, it afforded an advantageous railroad location on about 2½% descending grade to the dam. After determining the nature and extent of the rock by core borings, the contractor, H. S. Kerbaugh, Inc., purchased about 50 acres on the ridge, constructed a two-track, standard-gage, stone-ballasted railroad between the dam and the quarry and developed the site on a large scale. Fig. 1 shows the quarry area and the plant layout. A small valley about 50 ft. lower than the top of the bridge divides it near the middle of the area. This the main track enters and the quarry has been opened to the general level of this track.

The rock is a gneissoid granite of grayish color having a streaked appearance. The upper layers are somewhat discolored and vary in color; the lower portions are more uniform in color and are very sound and clear. Across the grain it resembles closely the Barre granite. It

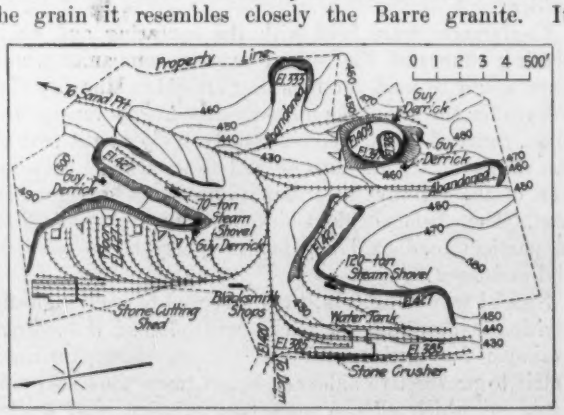


FIG. 1. PLAN OF QUARRIES FOR KENSICO DAM

*Division Engineer, Board of Water-Supply, Valhalla, N. Y.

FIGS. 2 AND 3. (LEFT) PLUGGED DRILL HOLES DISTRIBUTED OVER THE UNCOVERED YONKERS GNEISS LEDGES; DRILLS IN DISTANCE. (RIGHT) AFTER THE BLAST

polishes well, and where accessory minerals occur, it presents a varigated appearance.

As concrete aggregate and cyclopean stone were the first products needed, the development began with these in view. North Hill was stripped, revealing several acres of glacial worn ledge (Fig. 2). A through cut was made on the western side at the level of the valley. The blasted rock (Fig. 3), loaded by a 120-ton Marion shovel with 5-yd. bucket into side-dump cars of 8-yd. capacity, was hauled to the crusher in 6-car trains. Simultaneously six other openings were made, where cyclopean stone was quarried and loaded by derricks onto 12-yd. flat-cars. During the first season (1913) about 220,000 cu.yd. of crushed stone and 75,000 cu.yd. of cyclopean stone were produced.

The succeeding winter was spent in developing the quarry for the following working season. The east side of North Hill and the west side of South Hill were drilled and blasted for crusher stone, providing work for two steam shovels. The cut on the west side of North Hill was developed for cyclopean stone and equipped with 10 derricks and Southeast Hill was opened for the dimension-stone quarry. A very good quality of rock in thick sheets was found here at a depth of 30 ft. below the general surface. In 1914 340,000 cu.yd. of crushed stone and 120,000 cu.yd. of cyclopean stone were pro-

FIG. 4. QUARRY IN SOUTHEAST HILL WHERE THE 8x12-FT. PIECES WERE OBTAINED

duced. During this year active work on the dimension stone was begun and 9,000 cu.yd. was cut and dressed.

During the past season the principal product was for dimension stone. The west face of North Hill was worked for the smaller sizes. Southeast Hill was quarried for the larger stock and at a depth of 50 ft. some remarkably thick, clear and uniform sheets were developed, providing stock for the largest stones required, which were 8x12 ft. (Figs. 4 and 6). The byproduct from these two quarries provided all of the crushed stone and cyclopean stone required. From the beginning the quarry has been operated so as to utilize the entire product, and there has been practically no waste.

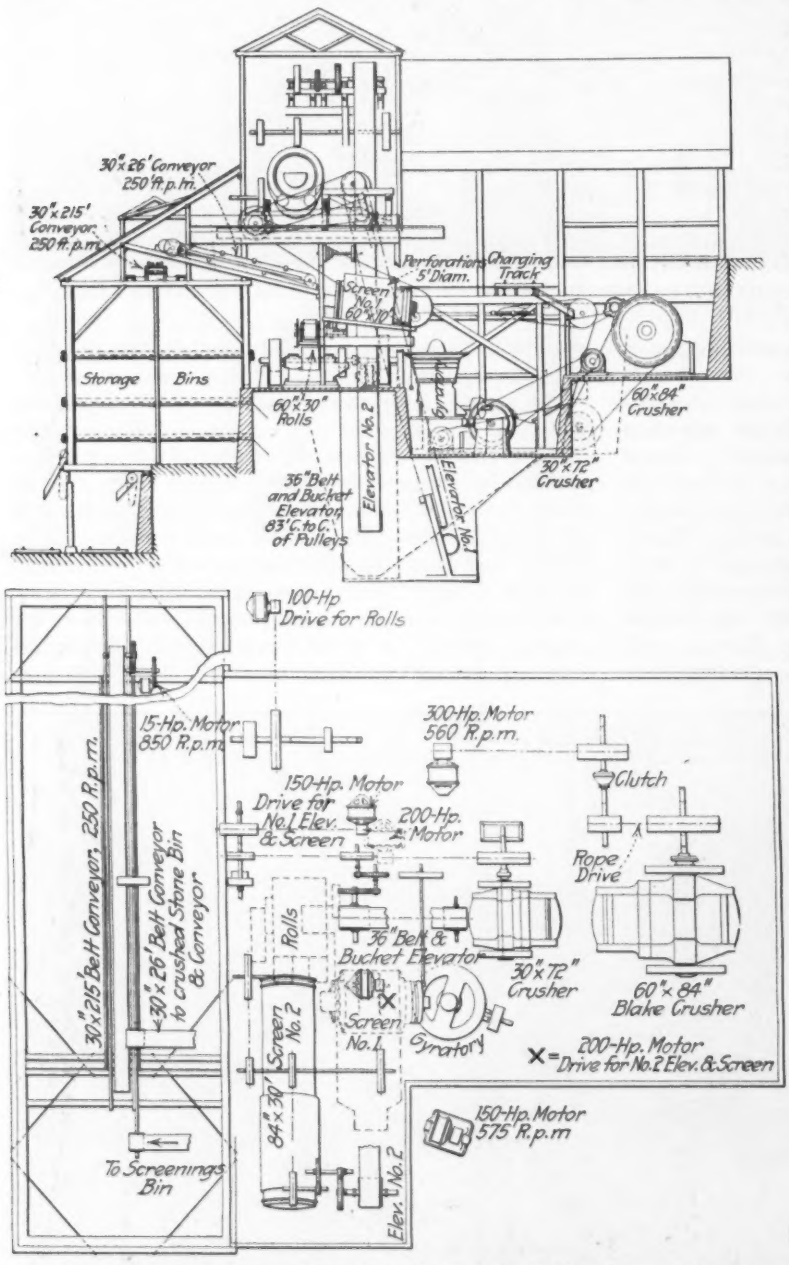


FIG. 5. CROSS-SECTION AND PLAN OF LARGE TEMPORARY CRUSHING PLANT

Two distinct types of drills were used for drilling the deep holes for large blasts in the quarries for crusher stones—the Temple-Ingersoll electric air wagon drill (type 5-F), and the Star drilling machine of the oil-well type, using a bit 4½ in. in diameter. The Temple-Ingersoll drills were effective only to a depth of 48 ft., and averaged 30 ft. a day. The well drills were effective to any depth and averaged about 7 ft. a day.

As a result of two years' experience, it was found that for the crusher stone the most economical spacing of the holes was 15 ft. c. to c. up to 45-ft. depth. Deeper holes were spaced 20 ft. Where it was desired to obtain some cyclopean stone in the large blasts, the well drills gave the better results. With these the most economical spacing of holes was 25 ft. in lines 50 ft. apart, parallel with the axis of the cut. This spacing averaged 46 cu.yd. of rock per foot of depth. Both types of holes were heavily sprung. This operation was more easily accomplished in the larger holes of the well drills, and this considerable advantage tends to the favoring of the well drill for this class of work. For the regular quarry work the Type 5-F Temple-Ingersoll electric air tripod drill was used for holes up to 25-ft. depth. The equipment consisted of four electric carriage drills, four well drills and nine tripod drills. Electric current was furnished from the transformer house at the dam at 2,000 volts and stepped down to 250 volts at the quarry. In the crusher-stone quarries it was desired to break up the stone to a size convenient for the steam shovels to handle. The first year three large blasts were fired in North Hill, the charges and spacing of holes varying somewhat in order to determine which would give the best results. The holes were all drilled by the Ingersoll-Rand drills and were from 15 ft. to 40 ft. deep. The quantities are as shown in the table below. The average charge of dynamite per cubic yard of rock loosened for all three blasts was 0.15 lb. for springing and 0.52 lb. for blasting. In the second season the well drills were used. The average depth of hole was 40 ft., and on the adopted spacing of 25x50 ft. each hole represented about 1,840 cu.yd. of rock. The normal charge of 0.6 lb. dynamite per cu.yd. required about 1,100 lb. in each hole. It was therefore necessary to spring, or chamber, the holes at the bottom to a size that would receive the charge. In the deep holes this meant a chamber 5 ft. in diameter, and to obtain this each hole had to be sprung a number of times. In some instances as much as 750 lb. of dynamite was used to obtain the required chamber.

No. of Holes	Lin. Ft. Holes	Cu. Yd. Loosened	Lb. Dynamite Springing	Lb. Dynamite Blasting	Electric Exploders
85	2,028	62,670	6,050	20,150	505
135	2,416	36,968	4,000	24,100	550
200	8,000	120,000	22,000	65,000	4,100

The crusher was located on the steep westerly slope of South Hill, with the floor 45 ft. above the track level under the bins. It consisted of a primary 60x84-in. jaw crusher of the Blake type. The product passed to the secondary crusher of the same type, 30x72-in. This reduced the stone to about a 4-in. size. The product was raised in a 36-in. bucket elevator and delivered to a 6x12-ft. revolving screen having 5-in. holes. The stone passing this screen fell to the foot of a second bucket elevator. The rejections went to a No. 8 McCully gyratory crusher and to the second elevator. This took the combined product and lifted it 80 ft. to a revolving screen 7 ft. in diameter by 30 ft. long, equipped with dust jacket and 3-in. holes. The material passing this screen was delivered to the storage bins by belt conveyors, the rejections falling to a pair of 60x30-in. crushing rolls and returning to the main bucket elevator. All of the parts are operated by electricity, there being seven units with a combined horsepower of 1,115 (Fig. 5).

The bins, with a capacity of 8,000 cu.yd., are of framed timber fireproofed on the outside with cement stucco (on wire lath) applied with a cement gun. The crusher

FIG. 6. ROOFED-OVER PORTION OF CUTTING YARD

house is partly steel frame covered with corrugated iron. The stone cars dump directly into the hopper of the primary crusher. The average output of crushed stone was 140 cu.yd. per hr., with a maximum of 200 cu.yd. During the season of 1914 the crusher was operated two shifts per day in order to maintain the supply to the dam.

Stone-Cutting Yard

The exposed downstream surface of Kensico Dam is faced with stone masonry (see *Engineering News*, Sept. 2, 1915). The design emphasizes the magnitude of the structure by the use of large stones and rough cutting, while the architectural details of pavilions, fountains, etc., require dimension stones of elaborate shape and fine cutting. To prepare the 22,000 cu.yd. of dimension stone of all classes, a cutting yard was established at the north end of the quarry. This is 60 ft. wide by 320 ft. long, and is covered by a 25-ton Shaw electric bridge crane. For 185 ft. the yard is roofed over (Fig. 6). About 75 stone cutters with attendant labor have been employed for two years in dressing the required stone. Pneumatic tools are used to the extent possible. The equipment includes nine Oldham surfacing machines and 50 plug drills.

The Massachusetts Lien Law as Revised

The agitation to obtain modification of the lien laws of Massachusetts at length resulted in a new law being passed, in 1915, which became effective on Jan. 1, 1916. The old law provided that no liens should attach for materials "unless the person furnishing them, before so doing, gives notice in writing to the owner of the property to be affected by the lien (if such owner is not the purchaser of such materials), that he intends to claim such lien." The new law does away with the requirement of notice to the owner and contains three provisions described by the Master Builders' Association of Boston, as follows:

1. That any person who enters into a written contract with the owner of land, for the whole or any part of the erection, alteration, repair or removal of a building or structure upon land, or for furnishing material therefor, shall have a lien upon said building or structure, and upon the interest of the owner in said lot of land as appears of record at the date when notice of said contract is filed or recorded in the registry of deeds for the county or district wherein such land lies, to secure payment for all labor and materials which shall thereafter be furnished by virtue of said contract.

2. That any person who shall, subsequent to the date of filing or recording notice of a contract as above described, furnish labor or materials for the property involved under a contract with a contractor, or with any subcontractor of a contractor, shall be entitled to a lien upon the premises described for any labor performed or labor or materials furnished subsequent to the filing or recording of said notice and prior to termination of contract as stated in notice.

3. The notices of the existence of such contracts with an owner may be filed or recorded by any person entitled to a lien under the Act.

The right of lien of a personal laborer remains as under the old statute, save that his right is limited as to extent of his lien, by the proviso that it shall not hold for more than 18 days' work actually performed during the 40 days prior to the filing of his statement of claim.

The Association appears to feel that the law as amended should satisfy all parties concerned, claiming that the contractor is given right of lien, which he never had before, dependent only upon the filing at the Registry of Deeds of a simple form of notice of the fact of his contract. The subcontractor and the supply man have the right of lien dependent only upon filing notice of the existence of the general contractor's contract with the owner. The loaner of money on security which real estate furnishes has the record to guide and protect him, while the owner has definite and certain rules to govern him.

A Motor Road Train equipped with the Thomas transmission system, a combined electrical and mechanical system of speed-varying power transmission, has been built by Armstrong, Whitworth & Co., and is now in operation in Yorkshire, England, according to the "London Times." The train consists of a tractor and two trailers. The total dead weight is about 14 tons. The tractor carries a 75-hp. gasoline engine which drives an electric generator, and also drives mechanically the driving axle of the tractor. In starting, most of the power of the engine is converted into electricity and drives motors on the two trailers. After the train is once started, so long as the adhesion of the tractor is sufficient to haul the trailers, the entire power is transmitted mechanically to the tractor axle so that there is no loss in electrical transmission. The various steps in the mechanical and electrical transmission give ten intermediate speeds. The steering of the trailers is automatic so that they follow in the track made by the tractor. The brakes on the trailers are operated electrically by the driver of the tractor. The train is capable of carrying a load of 20 tons which may be increased to 36 tons. The ordinary speed is 12 mi. an hour. It is claimed that 75 to 80 ton-miles can be obtained from a gallon of gasoline. Plans have been made for a five-vehicle train capable of carrying a maximum load of 60 tons. The equipment is controlled by the Thomas Transmission Co. of 14 Leonard Place, Kensington, London.

Jacketing a Railway Tunnel by Mining Methods

SYNOPSIS—A railway tunnel settled, dropping portions of the brick lining on the tracks. To keep traffic moving, it was decided to reinforce the lining from the outside. Working headings were driven on each side of the tunnel and material over arch excavated for from 7 to 10 ft. in height. Concrete was blown into this space, forming a thick jacket about the arch. The working drifts were then blown full of concrete.

A remarkable piece of tunnel reinforcing is nearly complete on the Pennsylvania R.R. main line at Greensburg, Penn., some 30 mi. east of Pittsburgh. For a number of years constant trouble has been experienced with the brick lining of portions of the Radebaugh tunnel. Parts of the lining became misplaced and fell on the tracks from time to time, but it finally developed that at least 850 ft. of the tunnel—which is about 2,050 ft. long—must be rebuilt or else the tunnel should be abandoned and an open cut made in its place. The cover over the tunnel is 150 ft. in maximum thickness. The cause of the trouble is that there is a vein of coal in the hill which the tunnel penetrates, and for 800 ft. or more the tunnel lining is supported on this vein. This soft coal gradually crumbled under the weight imposed and the tunnel settled.

After studying various plans of remedying the difficulty, it was decided to inclose the brick lining of the tunnel, where settlement had occurred, with a concrete jacket placed from outside the brick arch. This work is necessarily expensive. It is being done by the John A. Kelly Co., of Philadelphia, by force account. In spite of the novel nature of the work, there have been no accidents due to falls of brick during the 10 months of construction, and traffic has continued without interruption.

Working Heading Driven on Each Side of Tunnel

Excavation at the east end commenced in September, 1915. Headings were driven along the outside of the lining parallel to the tunnel and 10 ft. above top of rail. These drifts were 6x6 ft. inside the timbering. They advanced 3 ft. per shift, there being two shifts per day on each heading.

Some time previous to the contract, railway forces, in order to repair one of the breaks, sank a shaft at a point 850 ft. from the east portal and placed a concrete slab over the break and filled up the shaft. The contractor dug out and retimbered the shaft and used it as a means of access to the west end of the working drift. The headings started eastward from this shaft on Oct. 1, meeting at Sta. 4 + 50 in January, 1916.

The timbering of these drifts was never more than 6 ft. behind the face and consisted of 12x12's placed on 3-ft. centers. In January general excavation was started in both the north and south drifts making crossover galleries over the tunnel arch at seven points, the first being Sta. 3 + 45 (see Fig. 2). The muck was thrown down from the arch into the drifts, picked up by muckers, loaded into 4-yd. cars and hauled out by dinkey on a 3-ft. gage.

Timbering of the arch followed the excavation. The timbers were sawed by carpenters in the daytime and were erected in the daytime, 3 ft. each day, by the timber force. There were nine segments to the set, and every tenth ring of segments (at every 30 ft.) was omitted to make room for the blower pipe, all concrete being placed by the pneumatic system.

Pneumatic Concreting Plant

The concreting plant was laid out as simply as possible and was located about 200 ft. west of the portal. The sand and gravel bins were built over the feeding hopper above the blower, from which an 8-in. steel pipe ran through the north drift to the shaft. Thus the maximum distance of blow exceeded 1,000 ft.

There were two inclines in the piping, a 16-ft. rise to the drift and a 10-ft. rise to the top of the arch. The grade of the drifts, which was 0.4% (being the same as the grade of the tunnel), produced another and continuous rise in the piping. These rises, or inclines, are given great credit by the contractor for the fact that the batches were discharged without separation or distribution along the pipe run. The rate of placing concrete varied according to the length of the piping. When the work went on at its best speed, a ½-yd. batch was placed every 1½ min. In the longer runs 4 min. per batch was required. The batch must be out of the pipe line before another can be admitted.

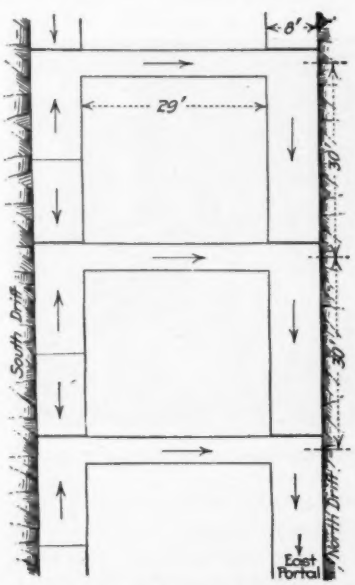


FIG. 1. HOW THE WORKING DRIFTS AND JUMPOVERS WERE CONCRETED

The compressor station has a capacity of 2,700 cu.ft. of free air per minute. There is plenty of air for blowing the concrete, for drilling the rock and for any other work requiring air power. This sufficiency of air is a vital point in the smooth progress of the work. Sand and gravel used in the concrete were brought by rail, as was also the cement, which was stored in a shed near the concreting plant.

The concreting proceeded in sections 30 ft. long between bulkheads. The 8-in. pipe was carried up to the center of the arch, and the concrete flowed out and ran down on either side. This scheme was carried out wherever feasible, in order to maintain an approximately equal pressure on both sides of the arch. At some points a flexible metal hose was used to distribute the concrete over the arch. The concrete flowed down to the side forms, filling these and then running over the roof of the drift, down the other

side of the working drift and under the floor of the drift, until the latter was entirely inclosed in concrete and formed merely an opening in the monolithic jacket. When concreting was first started, the floors of the working drifts were concreted for 200 ft. on both sides. All the timbering was left in, of course. The average thickness of the jacket varies from 5 to 7 ft. above the arch, with a maximum of 10 ft. The arch concreting was nearly complete by May 1. It was then time to begin to fill the working drifts, and this work was carried on as shown in Fig. 1. First, the extreme western part of the north drift was filled, the concreting pipe being withdrawn in an easterly direction during this operation. As indicated by the arrows, at the jumpover, which was a space left between the bulkheads over the arch to allow for placing the blower pipe, this pipe was carried over to the south heading, which was concreted in an easterly direction until the jumpover was reached. The concreting pipe was then

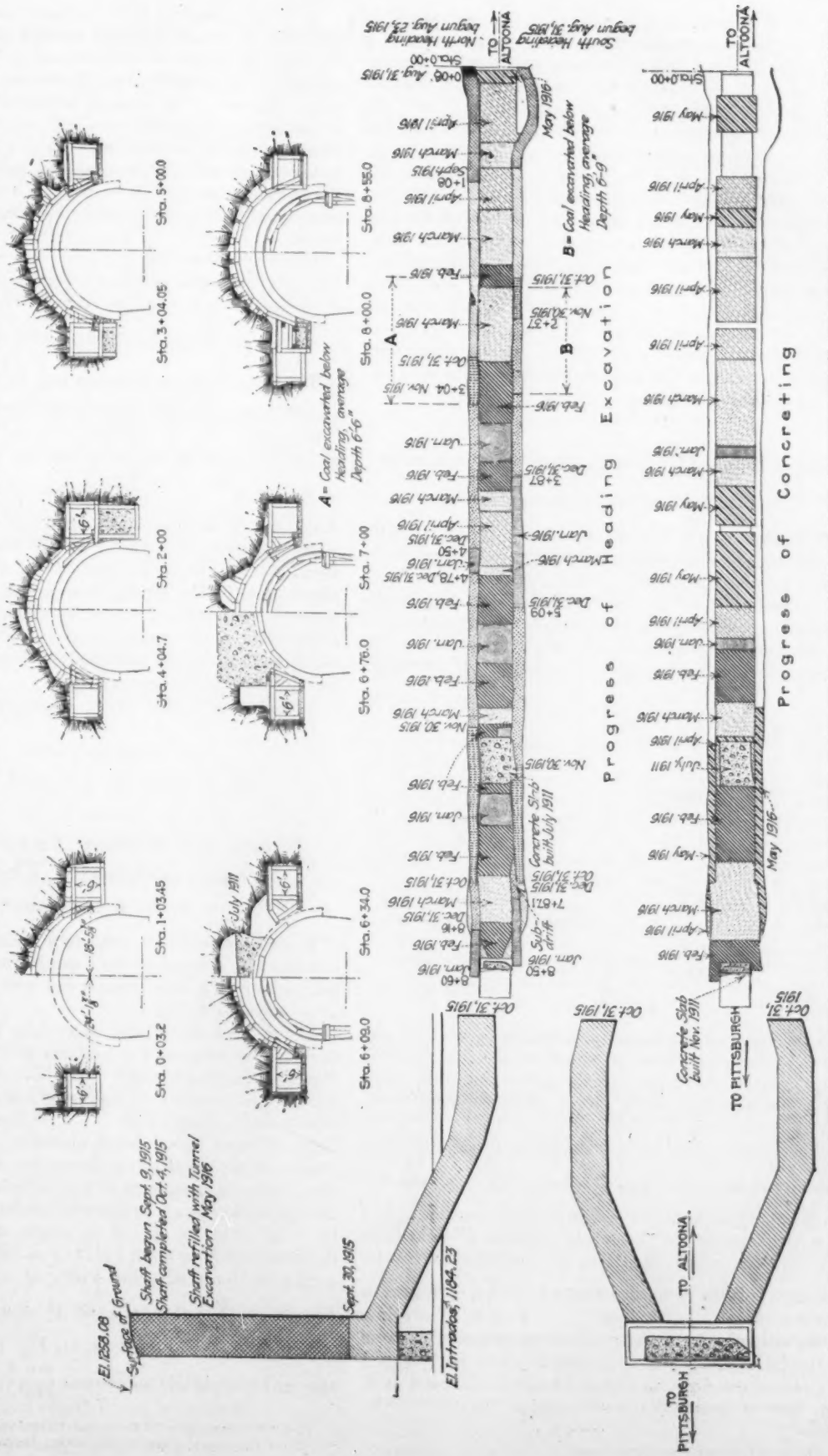


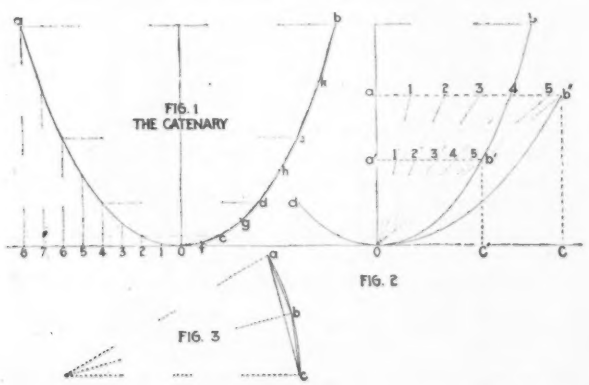
FIG. 2. PROGRESS OF THE EXCAVATION AND THE CONCRETING, WITH NUMEROUS CROSS-SECTIONS OF THE CONSTRUCTION; IN REPAIR OF RADEBAUGH TUNNEL

carried to a point half way between that bulkhead and the one just east of it. The pipe was withdrawn in a westerly direction, the drift being filled with concrete in this manner. When the concreting had reached the jumpover, the pipe was drawn through and the concreting continued. In the north heading the pipe was withdrawn in an easterly direction until the next jumpover was reached, when the pipe was carried across to the south heading and concreting started at the point where the last concrete in this heading had been placed, the pipe being withdrawn in an easterly direction until the bulkhead was reached and then being carried to the halfway point between bulkheads and withdrawn in a westerly direction until the jumpover was reached, when it was once more carried through to the north heading. This procedure was maintained until the two working drifts were filled with concrete. Meanwhile the shaft at the west end of the drifts was filled up.

Rectification of the Catenary

By Frederic R. Honey*

The catenary, which is the curve assumed by a perfectly flexible rope or chain whose extremities are fastened at the points a and b, the weight of a unit length being constant, is represented at aob in Fig. 1. Since plotting and rectifying the curve involve a great deal of numerical work, it is desirable to devise a means by which its length may be measured without reference to its equation. If plotted on



a large scale the drawing may thereafter be used for any catenary the proportions of which are assigned, and its length may be determined by the application of approximate measurements which give a result suitable for all practical purposes.

When the origin is taken at the lowest point o the equation of the catenary is $y = \frac{c}{2}\left(e^{\frac{x}{c}} + e^{-\frac{x}{c}}\right) - c$. In this equation any value may be assigned to the constant c, and e is the base of the hyperbolic system of logarithms (= 2.7183). The logarithm of this base is 0.4343. Making $c = 4$ the equation becomes $y = 2\left(e^{\frac{x}{4}} + e^{-\frac{x}{4}}\right) - 4$. For $x = 0$, $y = 2\ (e^0 + e^{-0}) - 4 = 0$. The values of the ordinates for the corresponding abscissas are given in the table, which may be extended indefinitely. Fig. 1 is a plot of the curve, in which the unit $0 - 1 = 1 - 2$, etc., may be assumed of any convenient length.

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If it be required to plot a catenary whose lowest point is o (Fig. 2), which shall pass through any assigned point b'' whose abscissa is oc and ordinate cb'', join ob'' intersecting the curve which is a reproduction in part of Fig. 1, at b'. The part of the catenary between the points o and b' is similar to the required curve ob'', which is a magnification of ob' in the proportion $ab'' : a'b'$. The length of the new unit on ab'' is determined by producing the lines drawn from o through the points 1, 2, 3, etc., on $a'b'$ intersecting ab'' in the corresponding abscissas for the enlarged curve.

Fig. 2 illustrates the catenary curve when the extremities are fastened at different levels b and d. So far as it is plotted it is a copy of the original, Fig. 1.

To Rectify the Catenary

The formula for rectification is $\frac{c}{2}\left(e^{\frac{x}{c}} - e^{-\frac{x}{c}}\right)$. Huygens'[1] approximation to the length of a circular arc is illustrated in Fig. 3, in which ac is the chord of the arc, and ab $(= bc)$ the chord of half the arc. The length of the arc is $\frac{8ab - ac}{3}$. The error—which may easily be discovered by trigonometry—when the radius of the arc which subtends an angle of 30° is 100,000 ft., is only about 2 in.—a negligible quantity in a measurement of about 10 mi. The length of an arc of a circle through the points o, f and c is practically equal to the part of the curve between the points o and c. Similarly the parts cd, de and eb may be measured; and the total length of the curve $ocdeb$ will be equal to

$$\frac{8(of + cg + dh + ek) - (oc + cd + de + eb)}{3}$$

VALUES OF x AND y

x = 1 y = 0.14	x = 3 y = 1.18	x = 5 y = 3.55	x = 7 y = 7.85
x = 2 y = 0.51	x = 4 y = 2.17	x = 6 y = 5.40	x = 8 y = 11.04

Flow of Water Into Wells; Approximate Theory

By N. Werenskiold*

When open wells are sunk to a horizontal impervious stratum and pumped to their maximum, the water table will be lowered to depression curves with very steep slopes, as is indicated in Fig. 1.

Assume that the original water table is horizontal, that the water-bearing sand is uniform and that the original depth of the groundwater is H. Let k = transmission constant for sand; r = radius of well; R = radius of depression (influence) circle; d = depression and h = depth of water in well when operated; x and y = coördinates of any point of the depression curve; z = height above impervious stratum of any particle flowing through vertical section y; α = angle with horizontal of depression curve at point (x, y); β = angle with horizontal of direction of flow at point (x, z); q = rate of flow through vertical section y with unit width; Q = rate of flow into well; $A = \frac{Q}{2\pi k}$; $B = \sqrt{0.384\ A^2} = 0.62\ A$.

With reference to point (x, z), Fig. 1, it seems reasonable and permissible to assume $\frac{\tan \beta}{\tan \alpha} = \frac{z}{y}$, and conse-

[1]See "Williamson's Differential Calculus," p. 67.

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quently the small amount flowing through a vertical section dz is

$$dq = k dz \tan a \cos^2 \beta$$

Integrating by the formula

$$\int \frac{dx}{1 + c^2x^2} = \frac{1}{c} tan^{-1} cx$$

we get, since x and y remain constant,

$$q = k \tan a \int_0^y \frac{dz}{1 + \left(\frac{\tan a}{y}\right)^2 z^2} = kya$$

Then $Q = 2\pi xkya$, and $a = \frac{A}{xy}$.

Within a maximum error of 2% of the arc, as may be readily checked by the use of trigonometric tables, the

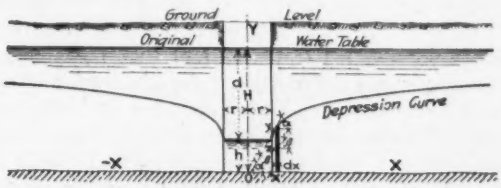


FIG. 1. DEPRESSION CURVE OF A WELL
For r = 0.2H, R = 50H, h = 0.265H, and d = 0.735H

relation between the tangent and the arc of an angle may be expressed by

$$tan\ a = \frac{a}{1 - 0.384a^2}$$

Thus, approximately, the differential equation of the depression curve becomes

$$\frac{dy}{dx} = tan\ a = \frac{A}{xy\left[1 - \left(\frac{B}{xy}\right)^2\right]}$$

There seems no way in which to integrate this directly; but since the last term in the denominator, and with it any error in this term, may be neglected with increasing values of x, it appears permissible to substitute (in this term only) an approximate value for y, such that $y = h$ for $x = r$. The hyperbola $y = H - \frac{(H - h)r}{x}$ gives sufficiently accurate results. It leads to

$$\frac{dy}{dx} = \frac{A}{xy} \frac{1}{1 - \left(\frac{B}{Hx - rd}\right)^2} = \frac{A}{xy} \frac{(Hx - rd)^2}{(Hx - rd)^2 - B^2}$$

$$ydy = A\left[\frac{1}{\left(1 - \left(\frac{B}{rd}\right)^2\right)x} + \frac{1}{2\left(1 + \frac{rd}{B}\right)\left(x - \frac{1}{H}(rd + B)\right)} + \frac{1}{2\left(1 - \frac{rd}{B}\right)\left(x - \frac{1}{H}(rd - B)\right)}\right] dx$$

$$y^2 = H^2 + 2.3A\left[\frac{2}{1 - \left(\frac{B}{rd}\right)^2} log \frac{x}{R} + \frac{1}{1 + \frac{rd}{B}} log \frac{Hx - (rd + B)}{HR} + \frac{1}{1 - \frac{rd}{B}} log \frac{Hx - (rd - B)}{HR}\right]$$

Where $rd + B$ and $rd - B$ can be neglected as compared with HR, this equation may be reduced to

$$y^2 = H^2 + 4.6A\ log \frac{x}{R}$$

Where the depression and slope are small, say a less than 0.524, $\cos \beta$ in the foregoing expression for dq may be assumed equal to 1, so that $dq = kdz \tan a$. From this, $q = ky \tan a$, $Q = 2\pi xky \frac{dy}{dx}$, $\frac{dy}{dx} = \frac{A}{xy}$, and $y^2 = H^2 + 4.6\ A \log \frac{x}{R}$, as before. On this assumption is based the theory which has been used for more than 30 years and which is ably treated in Turneaure and Russell's "Public Water Supplies" and in other works.

The relation between h and A, or Q, must be such that:

$$h^2 = H^2 + 2.3A\left[\frac{2}{1 - \left(\frac{B}{rd}\right)^2} log \frac{r}{R} + \frac{1}{1 + \frac{rd}{B}} log \frac{rh - B}{HR} + \frac{1}{1 - \frac{rd}{B}} log \frac{rh + B}{HR}\right]$$

$$= H^2 + 2.3AM$$

By first inserting an approximate value for B, or h, in the expression for M a more accurate value will be obtained by solving for A, or h. By substituting the value thus found in M a still more accurate value will be found, till the equation is satisfied. The first approximation may be obtained from the more approximate theory.

By assuming r, h and d as parts of H, R as multiple of H, and A and B as parts of H^2, a general and useful diagram, as shown in Fig. 2, may be prepared and used to compare the values of different wells.

While the transmission constant has been determined experimentally under certain conditions, it depends on

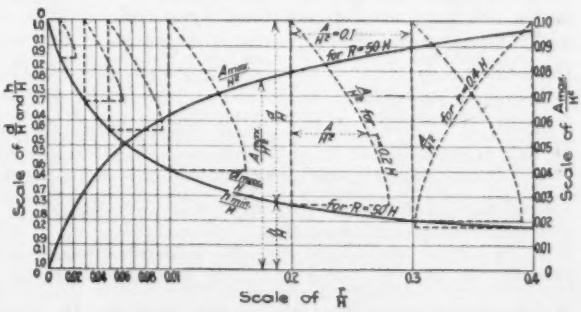


FIG. 2. DIAGRAM FOR COMPUTING THE RELATIVE FLOW INTO OPEN WELLS

so many factors that in practice it is merely a matter of judgment or assumption. Therefore a test well seems the only safe guide. If for $H = 17$ ft. and $R = 850$ ft., a 12-in. test well with $h = 11.5$ ft. and $A = 9.225$ gives $Q = 43{,}500$ cu.ft. per day, then a 10-ft. well with $h = 3.4$ ft. and $A = 25.85$ can be expected to yield 121,500 cu.ft. per day; $k = 750$.

No material increase in yield can be expected by lowering the level below the h shown on the diagrams. The effect of R should be tested.

A Path to Success in Engineering—The engineer who is neat and insists upon neatness from his subordinates in all work, whether in the office or field, will receive recognition from his superiors, favorable comment from the public, and will, whether he realizes it or not, have applied simple business principles, resulting in economical administration, which will stand out prominently in the larger projects he undertakes.—D. E. Henry, Acting Chief Constructing Engineer, Bureau of Public Works, Philippine Islands.

Experience with Applications for Employment

By C. A. Bock*

The advice contained in an article entitled "The Applicant's Difficulty," in *Engineering News* of June 8, by R. Fleming, deserves the careful attention of engineering graduates. The flood of applications from technical graduates following the June commencements tempts one to recommend that our colleges and universities prescribe a course of instruction in writing applications.

Application for an engineering position is commonly made by letter. As the prospective employer has no knowledge of the existence or qualifications of the applicant, except what is set forth on that particular sheet of paper, the applicant's future and his ultimate success depend largely upon the reaction produced by that letter. If the job is worth having, it must surely be worth the necessary time and effort to write a consistent application for it. Considering the vital importance of such application to both employer and applicant, it is surprising to find that the majority of such letters are carelessly written, poorly composed and are not prepared for by analysis of the factors involved.

During the past two years the Morgan Engineering companies have received and examined over 3,000 applications coming from engineers and technical graduates in all parts of the United States. A careful reading of these letters and a comparison as to their form, diction, spelling, punctuation, general arrangement, clearness and other qualities bring out some interesting information.

In the applications from college graduates common faults are poor spelling, careless handwriting, lack of definiteness, poor composition and a generally slovenly appearance. While it is not to be expected that a young and inexperienced man will turn out a faultless composition, it is assumed that if he has potential ability he will not exhibit gross carelessness in a letter of this kind. The habit of error and carelessness is particularly disqualifying for engineering work and will not be tolerated by competent engineers.

The applicant's greatest difficulty probably arises from his inability to appreciate the employer's point of view. He should remember that all the employer has to judge from is just what he sees in the letter. If he sees poor writing, spelling and diction, lack of definite information or meager information, presented in a disorderly manner, it is but reasonable to expect that he will form an indifferent opinion of the writer's ability. It is usually desired that the first letter give full information as to the applicant's qualifications. While often a number of letters may be exchanged before the man is engaged, the first letter makes the greatest impression.

The applicant must ask himself just what are the things that the employer would want to know about the man he wishes to employ. He must analyze the requirements of the opening he wishes to fill and then set forth his qualifications logically, in the order of their importance. This does not mean that qualifications should be manufactured to meet the requirements, nor that he should unduly enlarge upon his previous experience. Such expedients generally are very easily detected and reflect little credit on the man who resorts to them.

*Secretary, Morgan Engineering Co., Dayton, Ohio.

The letter should be concise and should come to the essentials without prelude, but must not be brief to the point of sacrificing pertinent information. A common mistake is that of devoting a long paragraph to stating that "I realize that a large number of applications will doubtless be received and that it will require a great deal of your time to read through them all, and it will probably be very difficult to decide," etc. Simple, direct statements, neatly written in well-balanced sentences, will nearly always make a favorable impression, and much can be accomplished by logical paragraphing.

A very short letter is not likely to accomplish much for the writer unless he is already personally known. Single-sentence letters or brief inquiries asking detailed information concerning the vacancy and telling nothing of the writer's qualifications at once give the impression that he would be more interested in personal advantages than in serving his employer and that he is not overanxious to secure the position. An illustration of this is, "Replying to your ad, I am interested in learning your needs and requirements. Upon receipt of same, if they impress me, I shall further communicate with you." This was received in reply to an advertisement for an experienced engineer to fill a responsible, well-paid position and requesting full information to be furnished in the first letter.

We do not mean to suggest that engineers should make a special study of writing applications in order that, by reason of their proficiency in this alone, they may be able to secure lucrative positions. Many capable and deserving men, however, do not realize the bearing that the writing of an application may have upon their prospects. Men of indifferent ability frequently secure positions simply through a favorable presentation of their supposed fitness, and it is often the case, especially with younger men, that the one who makes the neatest and best presentation of his qualifications secures the position rather than the one who has greater ability, but lacks the faculty of presenting his qualifications.

In replying to an advertisement or to a letter, any requests for certain items of information should be fully complied with. A point illustrating this requirement, which has repeatedly come to the writer's observation, is the fact that draftsmen, when asked for a small sample of their lettering, seem to think it necessary to submit several large bulky drawings even though these may have few lines and letters on them, instead of submitting a smaller sheet that would easily contain a fair sample of their work. They often aggravate the situation by requesting such large drawings to be returned to them immediately or by sending them under separate cover, with no distinguishing marks to indicate their source. It manifestly is impossible to give such applications a mature and careful consideration.

The hiring of men is a matter of first importance to the employer, as well as one of considerable difficulty. As the success of any undertaking depends to a very great extent upon the efficiency, both individually and collectively, of the men employed, it is to the advantage of both employer and employee that the man seeking employment shall not underrate his ability by a failure properly to present his case.

The following notes are taken from a careful examination of the applications received in reply to an advertisement in *Engineering News* for an experienced

engineer. The advertisement requested full particulars in the first letter, but the name of the employer did not appear.

Total applications examined	209
Number stating age	112
Number indicating training and education	133
Number stating years of experience	103
Number giving any references	77
Number giving indication of character and habits	40
Number stating salary desired	13
Number stating whether married or single	58
Average age of 112 applicants	35 yr.
Average experience of 103 applicants	12½ yr.
Average salary desired, 13 applicants	$280 per mo.

The significant fact of the foregoing summary is that, while each of the applicants presumably had some hope of securing the position, over 50% of them had no possible chance. Their letters were so lacking in essentials that they were at once barred from consideration by this insufficiency.

California Board Urges State Control of Dams

The Reclamation Board of California has just issued a report covering two years of its work in the supervision of private irrigation developments so that they may not interfere with the plans for flood control or with other reclamation works in the Sacramento and San Joaquin Valleys, in California. California has already taken the initial step in establishing state control over the construction of dams and similar structures whose building may affect the public safety. The board in its report points out, however, that to be effective the law should be so amended that the state can exercise a thorough supervision, not only of the dams during construction, but of their condition after completion. The President of the board is V. S. McClatchy, and its engineers are State Engineer W. F. McClure and Flood Control Engineer E. A. Bailey. The recommendations of the board regarding state control of storage reservoirs are as follows:

Storage reservoirs, whether operated in the interests of flood control, or power, or irrigation, or municipal supply, are a source of grave danger to the people and property below the dams. The use of such a reservoir creates a danger which did not exist prior to its construction, since it may hold back the flood and normal flow of its entire drainage area for one entire season or more. If the dam breaks, the flood precipitated on the country below the dam in a few hours may be twice, ten times, twenty times, in volume that which would have been precipitated in the absence of the reservoir by the forces of nature, and that much in excess of any protective measures adopted or possible to safeguard life and property below.

The public safety is entirely dependent on the strength of the dam. At the critical moment it may prove insufficient because of poor planning, or poor construction or defects which develop after construction. Concrete structures are particularly liable to develop defects (even when dishonest intent is lacking) because of poor judgment, poor material, insufficient proportions, improper mixing or climatic conditions. Lack of vigilance may permit grave defects to develop unnoticed, and it may be even possible so to operate a reservoir as to constitute a public nuisance if not a serious danger.

It would seem to be the duty of the state to exercise such control of the planning, construction, maintenance and operation of such structures that they may not offer menace to lives and property below them, and to forbid their construction or use if the necessary safeguards cannot be applied. The State Engineering Department, under existing conditions, would seem the logical department in which to repose the necessary authority. The legislature of 1915 provided that plans for such structures should receive approval of that department, but provided no penalty for failure to comply with the law and gave no power to the department to enforce its ruling as to plans, and no authority to supervise construction; nor did it provide for future inspection to detect the development of defects, or the right to prevent use of a dam if it seemed dangerous. In the judgment of this board, the law should confer powers and responsibilities such as are indicated and should impose the most stringent penalties, not in the way of fine, but of imprisonment, on those who, through intent or carelessness, violate or evade the intent of the provisions suggested or otherwise seriously endanger the safety of the people and property below the reservoirs.

State Highway Work in Florida

The law providing for a State Highway Department in Florida was passed more than a year ago, but it is only recently that a working organization has been created. The law provided for a commission of five members appointed by the governor—one member to represent the state-at-large, and one member each from the four congressional districts of the state. This commission has authority to appoint and fix the salary of a state road commissioner, "who shall be a competent and efficient road builder and well versed in the building of good roads." In April of this year the commission appointed William F. Cocke to this office.

The work of the department is now on a fairly permanent working basis, Mr. Cocke states, although it has not expanded sufficiently to require the services of an assistant commissioner, for whom the law also provides. This work of the Florida State Highway Department differs in some details from that of similar organizations. Aside from the usual functions of collecting statistics and furnishing advice it does more than other similar state highway departments whose jurisdictions do not include actual supervision of construction. It is constituted as a kind of headquarters inspection bureau. The following Section 5 of the law explains these duties:

The department shall as often as practicable have the road commissioner, or an assistant, visit the several counties and inspect the roads therein and the methods of road construction and repair and the materials used in building and repairing roads by the county commissioners therein, and make reports thereof to the department. All their records, books, contracts, machinery, implements, materials, properties and premises under the control or jurisdiction of the several boards of county commissioners, relating to or used in the construction or repair of roads, shall at all times be subject to inspection by the State Road Department, and shall be submitted by such county commissioner for inspection to the state commissioner, or such assistant as may be detailed to make such inspection. The county commissioners of the several counties in the state shall make and file with the department quarterly reports of and a detailed statement of all moneys expended on such work. Such reports and statements shall be made in such form as the department may prescribe and shall be filed with the department not later than 10 days after the last day of the quarter.

In all cases where the department shall learn that road repair or construction work is being improperly or extravagantly done, or improper or inferior materials are being used in such work, in any county, so as to cause a loss or waste of public funds, it shall be the duty of the department to notify the county commissioners of the same and point out to them the defects discovered, and if, after such notice is given, the county commissioners continue in the use of such improper methods or materials, the matter shall be reported to the governor by the department.

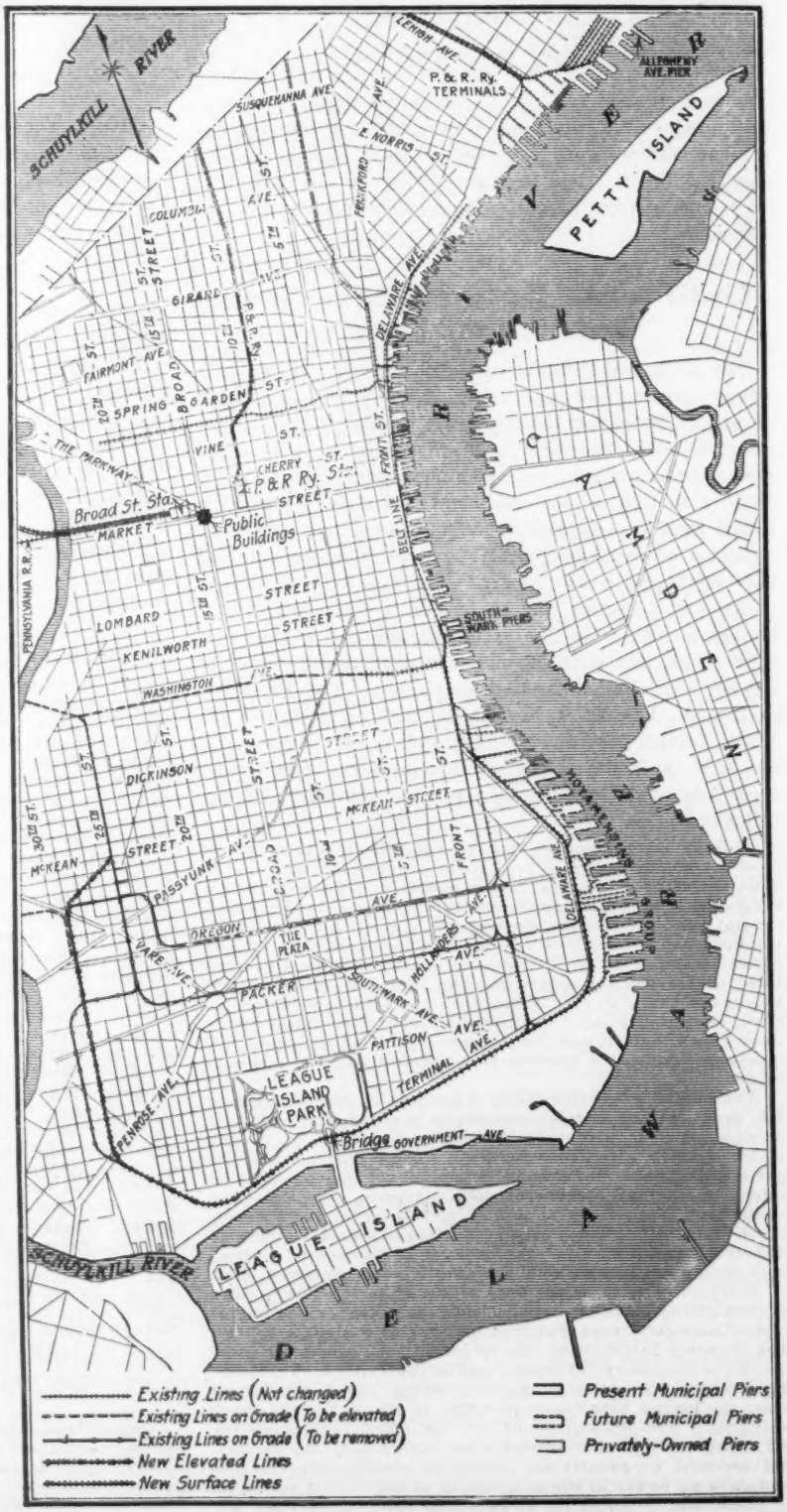
The law does not specify whether the governor shall reprimand or hang the offending county commissioners. But doubtless he could give them a good deal of unfavorable publicity, and this would be a strong factor in promoting better work.

Official Inspection of All Bridge Structures owned by railway companies within the limits of New York City are to be made by competent officials or employees of the companies and certified reports of the inspection report are to be filed with the Public Service Commission within thirty days after the end of each calendar year, according to an order just prepared by the Commission.

Terminal Railway and New Piers at Port of Philadelphia

Of the $115,000,000 voted in May by the citizens of Philadelphia, Penn., for public improvements, about $19,000,000 is to go toward port improvement, the money to be spent in new wharves and piers recently decided upon and for a large terminal railway project and rearrangement of the terminal lines at the docks, a scheme of some years' standing. As shown in the accompanying drawing, the Philadelphia river-front along the Delaware River is highly developed commercially. Of the great number of piers, however, only a few are under municipal ownership. The new appropriations are to be put into municipally owned piers under the following program: Ten million dollars is to be used for the construction and improvement of wharves and docks, including the acquisition of land and the construction of bulkheads. The items are as follows (the locations of various piers noted may be found in the drawing): (1) To complete the McKean St. pier which is now under way, $300,000. This pier will be 250 ft. wide by 900 ft. long. It is of the two-story type with pile foundation and structural steel and reinforced-concrete superstructure. (2) For the purchase of a site and the construction of a one-story pier about 80 ft. wide and 530 ft. long near Cherry St. in the center of the city, for small river traffic, $750,000. (3) For the purchase of property and the construction of a double-deck pier 80 ft. wide by 550 ft. long similar to the new piers in the Southwark group (See *Engineering News*, Aug. 26, 1915, p. 420), $1,000,000. This pier is to be used for general commercial purposes and is to be located near the foot of Kenilworth St. (4) For purchasing property and extending the Allegheny Ave. pier at the northern part of the city, this pier to be used as a general freight landing for river steamers and for recreation purposes, $500,000. (5) For the purchase of property and extension of the pier at Penn Treaty Park and also the pier at Bridge St. in Bridesburg in the northern part of the city, for general freight purposes and for river steamers and recreation purposes, $100,000. (6) For the completion of the bulkheading of the Schuylkill River, $750,000, and (7) for the acquisition of property and the erection of modern piers on the Delaware River front 1,000 ft. from the new McKean St. pier and what is known as the Moyamensing group, and possibly for the erection of new piers in the north and central portions of the waterfront, estimated cost $6,600,000.

The Moyamensing group project, noted in the last item, is the most important development in the Port of Philadelphia, and is tied up with the new terminal railway schemes for which nearly $9,000,000 additional



MAP OF PHILADELPHIA, SHOWING PROJECTED MUNICIPAL PIERS AND PORT RAILWAY DEVELOPMENT

has just been appropriated. The south end of the City of Philadelphia has never been properly developed. At the extreme south end of Broad St. is League Island, with its Government Navy Yard, lying off the peninsula between the Schuylkill and Delaware Rivers. Extending therefrom along the Delaware River north is a large stretch of waterfront occasionally developed by big factories, but very little used for wharf purposes. The commercial pier development extended from the north end of the city to the railway terminals about halfway between the center of the city—that is, Market St.—and League Island. These terminals were approached through two cross-streets on grade—Washington Ave. and Oregon Ave.—and for many years the southerly extension of the city had been effectively stopped by these crosstown grade lines. Under an agreement made with the Pennsylvania Railroad Co., the Baltimore & Ohio Railroad Co. and the Philadelphia Belt Line Railroad Co. (the latter operating a marginal jointly used line along the waterfront street) the city and the railways exchanged property along the southern end of the Delaware River waterfront, so that the new system of municipal piers could be built and the railway terminals shifted farther south. By this same agreement, the tracks on the Washington Ave. approach to the river are to be elevated and the Oregon Ave. approach removed so that all grade crossings in this part of the city are to be eliminated.

The new terminal yards will be approached by a four-track line around the south end of the city and paralleling the river up to the yards. For this project the sum of $3,300,000 is to be devoted to buying property from the railroads for the erection of municipal piers; about 2,400 ft. of waterfront from the Pennsylvania R.R. and about 925 ft. from the Baltimore & Ohio R.R. The remaining $5,600,000 is to go toward construction.

Delaware Ave., the marginal street, is now being extended to the southward in a width of 200 and 250 ft., which is believed to be ample for the present and future accommodation of both railroad and vehicular traffic. There is now being constructed in the bed of this street a four-track railroad made with 159-lb. grooved girder rails for the joint or Belt Line R.R., with provision for two additional tracks when business shall demand. This avenue is being paved for its entire width with dressed granite blocks upon a heavy concrete base, thus providing a smooth surface for trucks and other vehicular traffic.

A bridge has been constructed along the line of Broad St. over the joint or Belt Line R.R., just outside the League Island Navy Yard, thus avoiding the necessity of crossing tracks there at grade. By the removal of the present surface tracks of the Baltimore & Ohio Railroad Co. on Oregon Ave. and the tracks of the Greenwich branch of the Pennsylvania Railroad Co., and by the elevation of the railroad in Washington Ave., fifty-six grade crossings will be abolished and an unimproved territory covering over 4,000 acres, located within a comparatively short distance from the center of the city, a territory which has been hampered in its growth by reason of barriers which the railroads formed, will be capable of development for industrial and residential purposes.

As a part of this proposed development, League Island Park is now under construction, as shown in the map. This park is to be a highly ornamented city development with a boulevard extending on the line of Broad St. to the gate of the League Island Navy Yard. Radiating from the plaza at the head of the park are to be wide avenues reaching the two rivers and opening up the new area which will be provided with regular cross-streets with somewhat larger blocks than is customary in old Philadelphia practice. It is hoped, then, that this new area will speedily be built up with small residences of the type so familiar to those who have visited Philadelphia, and that the waterfront areas will be taken up by industrial works.

The harbor development in Philadelphia is under the direction of George S. Webster, Director of the Department of Wharves, Docks and Ferries. The railway grade elimination was under Mr. Webster's direction also when he was Chief Engineer of the Bureau of Surveys, in which place he has been succeeded by Chester E. Albright.

Municipal Alum Manufacture; Kingston-on-Thames

The manufacture of sulphate of alumina from bauxite by boiling the bauxite with sulphuric acid and water appears to have been carried on by the Borough of Kingston-on-Thames, England, since 1910. The plant at the place named was described some time ago by R. H. Clucas, Borough Surveyor of Kingston-on-Thames, in a paper read before the Institution of Municipal and County Engineers. Mr. Clucas states that he visited the similar plant being operated by the Borough Surveyor of Chorley, England, before he was authorized by his own borough to proceed with the erection of an alumina plant.

The Borough of Kingston-on-Thames uses its sulphate of alumina for treating sewage. Prior to the installation of the plant it employed aluminoferric. A total of 800 long tons per year was used, and the cost was 49½s. per ton. The municipally manufactured alumina cost 30s. per ton, showing a balance, according to Mr. Clucas, of £780 a year, or well toward $4,000. The amount of sewage treated a year is about 2,000,000 U. S. gal., the rate of application averaging 25 grains per Imp. gal.

The boiling vats at Kingston-on-Thames, two in number, are each 5x5 ft. in plan by 4 ft. high, made of 1½-in. lumber lined with lead. In each tank there is a coil of 1½-in. lead pipe having a total length of 42 ft. Steam for these coils is supplied from a boiler, and compressed air is used for agitation. The bauxite is first broken up by a rotary crusher and then ground to 80- to 100-mesh fineness in an emery mill.

To produce one long ton of sulphate of alumina, there are used 672 lb. of bauxite, 1,008 lb. of water and 1,008 lb. of sulphuric acid. These are boiled in one of the vats at 220° F. for about 7 hr., after which the material is run into molds. The bauxite is bought on the basis of 40% alumina, samples dried at 212° F.

The existence of these English plants of comparatively long standing is of interest in view of the establishment of a municipal plant at the Columbus, Ohio, water-purification works a couple of years or so ago.

Tunnel Ventilating Plants are being installed on the St. Louis line of the Baltimore & Ohio R.R. between Clarksburg and Parkersburg, W. Va. The system is similar to that at the new westbound tunnel at Kingwood, large steam-driven fans at the portals driving a fresh-air current in the direction of the train. One such plant has been completed at Eaton, another is being built at West Union and two others are to be built this season at Silver Run and Ocean.

Flat-Slab Floor Failure Due to Poor Brick Wall Columns

SYNOPSIS—A series of collapses beginning Mar. 24, 1916, wrecked the shop building of the Boys' Industrial School at Roxbury, Mass., a structure with concrete interior columns, brick wall piers and girderless concrete floor slabs. The article herewith is a brief summary of a report made by Sanford E. Thompson, from an investigation soon after the accident.

The shop building of the Boys' Industrial School at Roxbury, Mass., as shown diagrammatically in Fig. 1, is a reinforced-concrete structure 202 ft. 8 in. long, 62 ft. 8 in. wide and three stories high at the north end and two stories at the south. The structural elements are approximately square panels (22x20 ft. 3 in. in general)

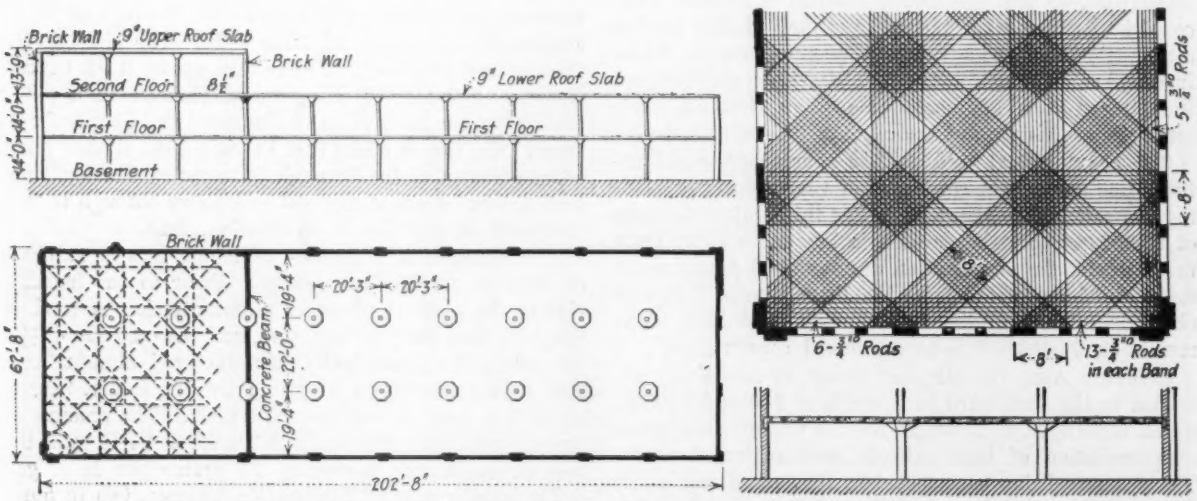


FIG. 1. DIAGRAMMATICAL LAYOUT OF FRAMING OF SHOP BUILDING, BOYS' INDUSTRIAL SCHOOL, ROXBURY

of flat-slab floors resting on the octagonal column heads of longitudinally reinforced square columns. The walls, of brick, were broken by brick wall piers which took the reaction of the wall panels of the flat slabs, as shown in detail in Fig. 2. On the roof, to give proper slope, a cinder concrete fill with a 2-in. mortar surface had been placed. This varied in thickness from 17 in. to 3 in.

Following the first collapse a thorough investigation of the building was made by Sanford E. Thompson, Consulting Engineer, Boston, Mass. The following report is in Mr. Thompson's own words:

Report by Sanford E. Thompson

From inspection of the original records on the job, I have the following information:

Location	Concrete Poured	Forms Removed
Basement columns	Nov. 24, 1915	Dec. 9, 10, 1915
First-floor slab	Dec. 1, 3, 4	Dec. 24, 27, 28, 31
Columns supporting second floor and lower roof	Jan. 5, 6, 1916	Feb. 10, 11, 12, 1916
Second floor and lower roof	Jan. 6, 7	Mar. 6, 7, 8, 9, 20, 22
Columns supporting upper roof and upper roof itself	Feb. 2, 5	Feb. 20 (column)
Cinder fill on lower roof	Jan. 24, 25, 26	Mar. 22 (posts next to wall)
Cinder fill on upper roof	Mar. 23	

Collapses occurred Mar. 24, 25 and 29.

I understand that the sand and stone for the concrete were thoroughly heated. I am advised also that the brickwork was laid in advance of the concrete construction, that the window openings were protected by canvas, that salamanders were used on the floors, and the fresh concrete protected.

The foregoing table shows that the forms under the second floor and lower roof were left in place more than eight weeks. Occasional 3x4-in. posts, spaced about 11 ft. apart, were under the lower roof, at the time of my first visit after the first collapse. Before removal of any of the forms, I am advised that the concrete was examined and tested by blows in the presence of the city building inspector.

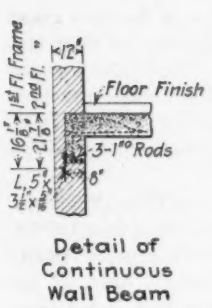
At the time of my first visit on Saturday, Mar. 25, I found the roof and the second floor of the high portion of the building had collapsed and were hanging on the reinforced-concrete beam which was designed to support the rear wall of the second story of the high portion. The remainder of the building was intact. On the following day, Sunday, Mar. 26, I was advised of a further collapse at 7 o'clock the night previous, and again visited the job. I found the lower roof had fallen, bringing with it a part of the first floor at the south end of the building. The first floor in the north end, although badly deflected and cracked, and the column cap badly cracked, held the weight of the entire material of the second floor and roof, besides having sustained the impact of the fall. This is shown in Fig. 3.

Not till three days later, on Mar. 29, did this portion of the first floor finally fall, leaving even then the basement columns still in a nearly vertical position.

Examination of Structure

During my different visits to the job, I examined the brickwork and the concrete carefully, and took various samples, the tests of which are described later.

The mortar in the brickwork was much of it frozen, and the part which had thawed was easily crumbled in



COLUMN SCHEDULE

	2nd Story Portion		1st Story Portion	
Roof	Mix.	Size	Mix.	Size
2nd Floor			1:2:4	12"x12"
1st Floor	1:2:4	12"x12" 4-1" Rods	1:1½:3	15"x15" 6-1" Rods
Basement	1:1½:3	16"x16" 6-1" Rods	1:1½:3	18"x18" 8-1" Rods

Use ¼" hoops, 12" C. to C.

FIG. 2. DETAILS OF A TYPICAL FLOOR

the fingers. From the appearance, it was evidently a lime and cement mortar, with a preponderance of lime. This afterward proved to be the case by chemical test, as noted further on. The brickwork was not constructed with the care required for piers, or for a wall supporting a long-span slab. The horizontal joints varied in thickness ranging up to 1⅝ in. The vertical joints were many of them open for a depth of several courses. Headers in some cases were blind instead of being full. The face brick in many cases was peeled off from the backing, and cracks between them are frequent. The piers between the windows in the top story of the main building, which were laid under conditions corresponding to those of the shop building, were found by measurement to have buckled, the face course being bulged out from the backing. As a whole, the brickwork in the shop building was very poorly constructed for carrying out the intent of the design.

The concrete in the second floor and the roof slabs was not thoroughly hard. It contained moisture and some frost. I found a marked difference in the concrete, however, in different portions of the structure. The columns both in the basement and the first story appeared well hardened. This was shown by inspection and also by the fact that in places the surface of the column had been chipped with a cold chisel, without splintering. The concrete in the lower roof slab was least hard and very much weaker than the concrete of the second floor which was laid as a part of the same slab. The harder condition of the floor slab was due evidently to the better protection from the cold and the opportunity to dry out.

The concrete of the roof slab was well bonded with the cinder concrete fill, so well, in fact, that they would act together in resisting stress.

My criticism of the design relates chiefly to the improper combination of the reinforced-concrete flat slab with the brickwork. Such combination is a poor construction at the best, and, if unavoidable, special precautions should have been taken to provide for eccentric stresses and bending moments. Even the slight normal deflection of the slab which occurs under working loads tends to throw excessive stresses on the brick piers because of the eccentricity.

In the slab design, I would criticize especially the shape of the haunch which is flatter than required by

FIG. 3. FIRST FLOOR IN HIGH PART OF BUILDING AFTER FAILURE
The upper floor in this view is supporting the heavy load of the collapsed building

good authorities at the time of the design of this building.

In considering the cause of the collapse, it must be noted that the structure consisted of concrete roof slab, concrete columns, concrete floor slabs, and brick walls, and the failure must have originated with one of these. Considering each one of these: (1) The upper roof was laid last, but I am advised that practically all the supports still remained in place, so that the concrete could not have caused the failure. (2) The columns under the upper roof were under no appreciable load because of the supports under the roof. (3) The columns under the second floor were shown by examination and test of the concrete to be unquestionably strong enough to sustain the loads that came upon them. (4) The second floor was partly supported by occasional 3x4-in. struts, which assisted in carrying the weight of the roof and cinder fill. The roof itself also, although the concrete was not thoroughly hardened, had considerable strength thereby relieving the slabs below of a part of the load.

In this case it is necessary not simply to consider theory, but experience. Case after case has been brought to my attention of flat slabs which have sagged up to 3 in. without failure. One of these cases was in a building in Boston from which the roof forms were removed while the concrete was green—as green, in fact, as the concrete in the present structure. Notwithstanding this sag, which came on gradually, the slab is standing at the present time. The great strength of the first-floor slab in the present building, which supported, although with very great deflection and cracking, the impact and weight of the slabs above for a number of days before failure, is an indication of the normal action of a flat slab under excessive load. If the struts under the second floor slab had deflected only ½ in., the struts would have buckled out several inches, and long before this would have been noticed by those in the building. In view of these facts, I conclude that the collapse did not originate by failure of the second-floor slab.

Turning now to the walls, we find a 12-in. thickness for the two upper stories (4 in. of this being face brick), a quality of construction very poor for the requirements and a mortar consisting largely of lime and sand. I am informed also that instead of slaking the lime in advance, it was slaked just before using. As evidence of this, I find at various places in the mortar small pieces of unslaked lime. The mortar materials I am advised were not heated. Computing the stresses, I find on account of the weight of the long span that the brickwork probably received a stress of more than 250 lb. per sq.in. whereas tests of a portion of one of the brick piers showed the beginning of failure at 167 lb. per sq.in.

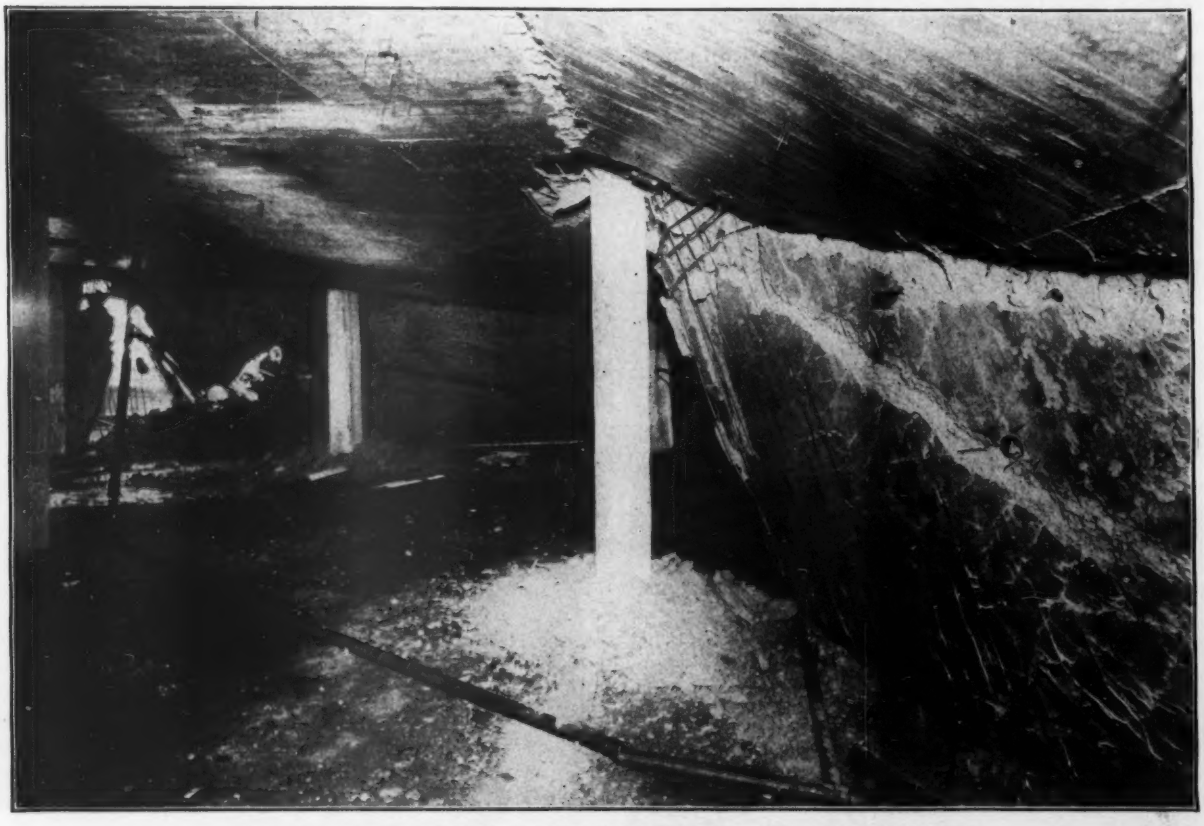


FIG. 4. BASEMENT UNDER LOW PART OF BUILDING AFTER FAILURE

In view of these conditions and as a result of examination, computations and tests, I am convinced that the failure of the building originated with the brick piers supporting the second floor. The conditions on Saturday, Mar. 24, the position of the columns, and the rest of the failed portions, indicate that the subsequent failure started at the junction with the ruins of the first failure. I am aware that a watchman who was at the rear of the building at the time of the second collapse states that the rear roof came down first. I believe that he is in error on this point, as it was impossible for him to tell from his position where the break started.

Brick Mortar—Three samples of brick mortar taken by me from the job were analyzed chemically. The result of the chemist's analysis is as follows:

Sample	Ratio Cementing Material to Sand	Analysis of Cementing Material	
		Cement, Per Cent.	High Magnesium Lime, Per Cent.
A	1 to 3.08	57.97	42.03
B	1 to 3.71	54.31	45.89
C	1 to 3.64	82.55	17.45

Sample A is mortar from the pier designated below as No. 1, which is pier on west face next to north corner pier. Sample B is from another pier in same section of building. Sample C is from a pier in rear end of building.

The specifications for piers require 1 part cement to 3 parts sand with not to exceed a shovelful of slaked lime to a bag of cement. Samples A and B, which are from the wall where the failure first occurred, represent approximately one barrel of lime to one barrel of cement. Allowing for the expansion of lime in slaking, we find instead of one shovelful of slaked lime per bag of cement (the limit of the specifications), (A) 13 shovelfuls, (B) 15 shovelfuls, (C) 4 shovelfuls of slaked lime respectively.

Brickwork—Two pieces of brickwork from brick piers in the portion of building which collapsed were tested for compression. The first sample, No. 1 (taken from the pier on west side next to north corner pier between first and second floors), showed a drop of the gage of the testing machine at 167 lb. per sq.in., or 12 tons per sq.ft., showing that a constant application of this load would have produced failure. The specimen actually broke at 550 lb. per sq.in., or 40 tons per sq.ft. The second specimen showed initial failure at 240 lb. per sq.ft., or 17 tons per sq.ft. with a breaking strength of 635 lb. per sq.in., or 45 tons per sq.ft. It is of course evident that the lower figures represent the actual value of brickwork in resisting the load.

Concrete—Chemical analysis of the concrete showed it to be in proportions 1 part cement to 6 parts of aggregate, or substantially 1 part cement to 2 parts sand to 4 parts stone, as called for by the specifications.

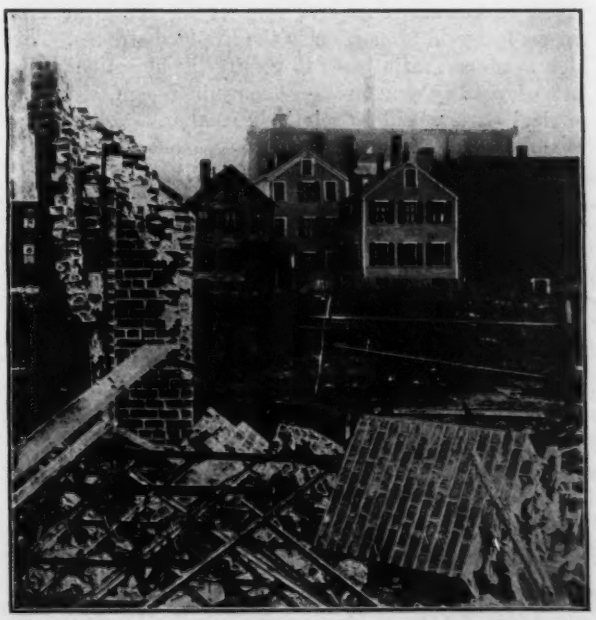


FIG. 5. CORNER PIER OF SHOP BUILDING, SHOWING VERTICAL JOINTS IN BRICKWORK

FIG. 6. NEAR VIEW OF PART OF BRICK PIER

A sample of this concrete hardened satisfactorily upon boiling, indicating its good quality and the fact that the low strength was due simply to the cold weather conditions.

A sample of the concrete, corresponding to the concrete in the columns between the first and second floors of the part of the building that failed first, showed a strength in compression of 1,350 lb. per sq.in., which is very much in excess of the stresses found by computation as caused by the loads.

No specimen of the slabs large enough to test could be obtained from the end of the building which first collapsed without endangering the men making the test. Inspection of the concrete, however, indicated it to be strong enough to carry the loads which came upon it.

Conclusion of Cause of Collapse

The evidence points clearly to the brick piers between first and second floors as the place of initial failure. The cause of the failure of these piers we find to be due to (1) their improper design for carrying a long-span flat slab; (2) the quality of the brickwork, which was not adapted to sustain the normal loads of the long-span slabs; and (3) the use of lime and cement mortar, where the specifications called for cement mortar.

If the structure had been built with properly designed concrete wall columns, it undoubtedly would be standing today.

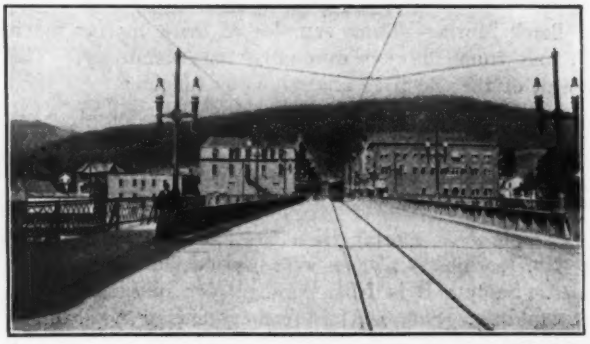
In reaching the above decision, due account is taken of the fact that the concrete in the floors and roof at time of collapse was not thoroughly hard, and in fact had not attained nearly the normal strength of concrete. I find, however, by actual test of the strength of the column concrete that the columns were amply strong to carry the load; also, from my knowledge of the action of flat slabs even of partly hardened concrete, I consider that such a sudden failure as wrecked the building could not have been produced by the failure of the slab.

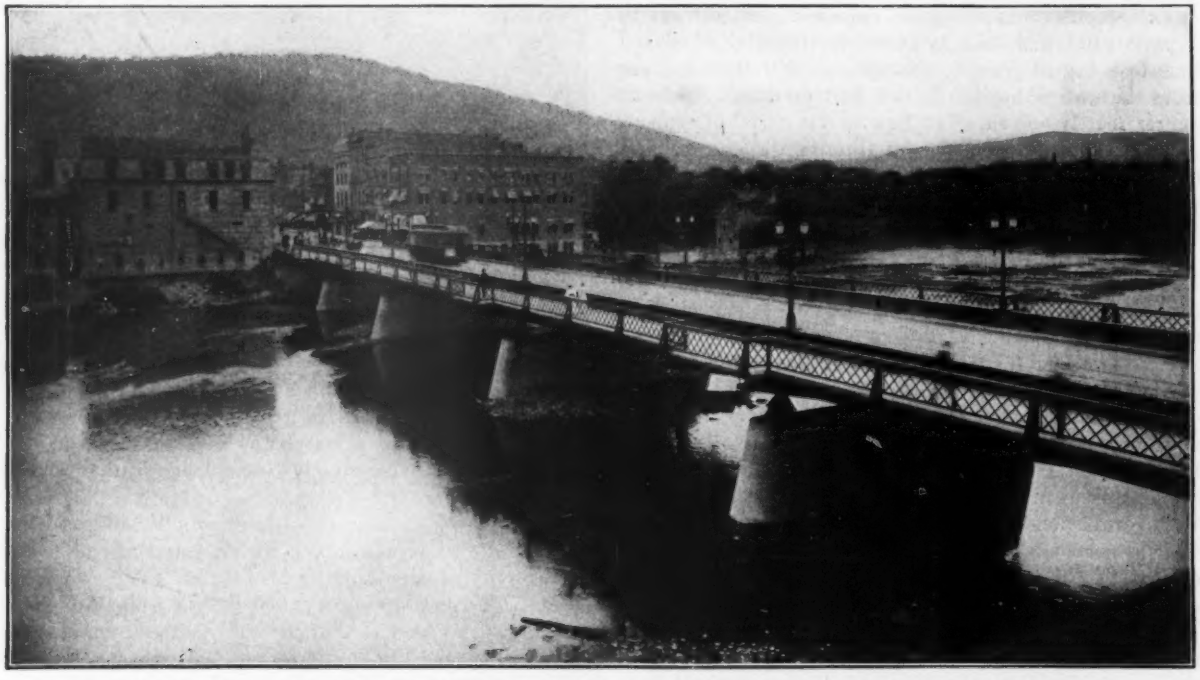
Plate-Girder Cantilever Bridge

By Arthur G. Hayden*

A remarkably unusual form of construction was adopted recently for a bridge over the Allegheny River at Salamanca, N. Y. The total length of the crossing is only 400 ft.; and as the foundation question was not very difficult, short spans were practicable. In spite of these conditions favoring the usual type of a series of simple spans, it was found that short-span cantilever construction was cheaper.

The objections sometimes raised against the cantilever bridge are lack of rigidity, and even lack of economy, as the writer has frequently heard maintained by engineering lecturers. Possibly the fact is sometimes overlooked that modern traffic requires heavier floor construction, which makes the dead-load stresses in the girders or trusses larger in proportion to the live-load stresses. This high dead-load ratio tends to nullify the objections as to lack of rigidity and favors economy in design, since the reversal stresses will be relatively smaller.





FIGS. 1 AND 2. TWO VIEWS OF MAIN ST. BRIDGE, SALAMANCA, N. Y., A CANTILEVER STRUCTURE WITH 80-FT. SPANS

*Bridge Engineer, Barge Canal Office, Albany, N. Y.

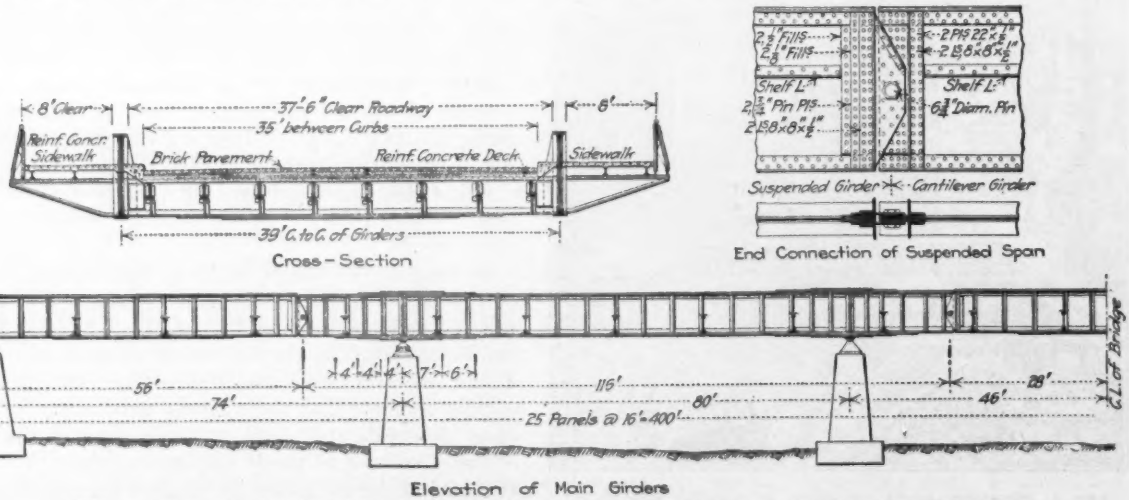


FIG. 3. GENERAL DRAWINGS OF SALAMANCA CANTILEVER BRIDGE, AND HINGE DETAIL

In 1911 the State of New York made an appropriation for a bridge of specified general dimensions across the Allegheny River at Main St., Salamanca. Studies were made for a bridge of the usual simple-span girder style, and by use of the customary methods the most economical number of spans was determined.

The river bottom being practically level, the cost of a pier was the same wherever located, about $3,800. The cost of two girders for one 80-ft. span was found to be $3,300, which approached more nearly the cost of one pier than the girders for one 100-ft. span or one 67-ft. span. This is the criterion for the most economical span length. The complete estimate for a bridge with five 80-ft. spans showed, however, that the cost would be above the amount appropriated.

Studies were then made for a cantilever bridge. Since the cost of floor and abutments is the same for simple spans and cantilever, it was only necessary to compare main girders and piers, the cost of the latter including the cost of excavation and pile foundations. The piers for the simple-span girders were required to be wider

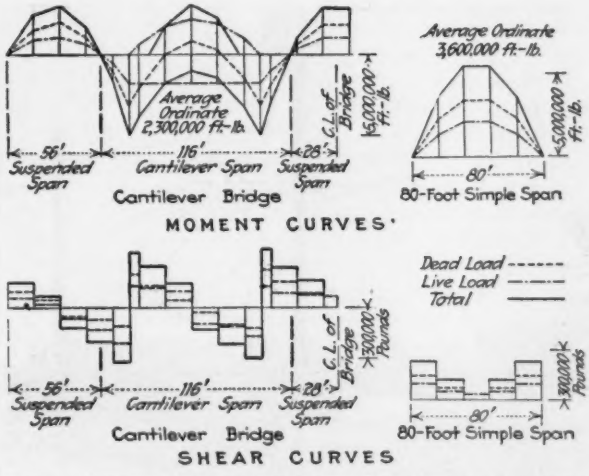


FIG. 4. MOMENT AND SHEAR CURVES FOR SALAMANCA CANTILEVER BRIDGE, AND EQUIVALENT SIMPLE SPAN

than for the cantilever girders in order to accommodate the bearings of the two adjacent spans. The comparison is given by the following table:

	Cantilever and Suspended Spans	Simple Spans
Girders, 455,000 lb. @ 3¾c.	.....	$17,100
Girders, 355,000 lb. @ 3¾c.	$13,300	.....
4 piers at $3,800	.....	15,200
4 piers at $3,500	14,000	.....
Total	$27,300	$32,300

It appears therefore that a saving of $5,000 is secured by the use of cantilever construction, nearly $4,000 of which is due to economy in the superstructure.

The data on which the designs were based and the comparison made included the following items: Total length of crossing, 400 ft.; width of roadway, 37½ ft. clear; two sidewalks, 8 ft. clear; floor, reinforced-concrete deck with brick paving; loading, 30-ton electric cars on one track occupying the middle of the roadway, 12-ton motor trucks on any part of the roadway and uniform live-load of 100 lb. per sq.ft. on parts of roadway not occupied by the concentrated load; impact, 50% for floor and stringers, 20% for floorbeams; unit stresses, 16,000 lb. per sq.in. in structural steel, 12,000 lb. in reinforcing steel, 500 lb. in concrete.

The foregoing comparison of cost is based on a rather low unit price. Ordinarily, the price bid for such work is higher and the economy of the cantilever structure would be greater. As to rigidity, to quote reports, the bridge is "solid as a rock" under fast-moving trolley traffic.

The accompanying drawings show the general construction of the bridge, and the kind of hinge used at the attachment of the suspended span, and also give a graphical comparison of the stress distributions in the simple and cantilever spans.

The entire cost of the new bridge, including substructure, superstructure, wiring and lighting system, laying rails and ties and the removal of the old bridge, was $77,681.10. This sum is itemized in the following table:

4,145 cu.yd. earth excavation @ 50c.	$2,072.50
973 cu.yd. rock excavation @ $1.50	1,459.50
511.5 cu.yd. first-class concrete @ $8	4,092.00
2,087.1 cu.yd. third-class concrete @ $7	14,609.70
857,837 lb. steel @ 3¾c.	32,168.89
0.79 ton cast-iron pipe @ $50	39.50
822 lin.ft. handrail @ $1.50	1,233.00
14,688 lin.ft. piles @ 40c.	5,875.20
1,886 sq.yd. brick pavement @ $1.50	2,829.00
127,277 lb. reinforcing @ 3c.	3,818.31
31,780 lb. cast steel and lead @ 7½c.	2,383.50
400 ft. laying rails and ties @ 50c.	200.00
Removing old structure, lump sum	1,350.00
Lighting system	3,500.00
Installing and wiring	2,050.00
Total	$77,681.10

The bridge was designed by the New York State Barge Canal Office, Albany, and was built by the Owego Bridge Co., of Owego, N. Y.

Baltimore Activated-Sludge Air Diffusers

Interesting experiences with filtros-plate air diffusers in the large activated-sludge tank at Baltimore, Md., were reported by Leslie C. Frank, Sanitary Engineer, United States Public Health Service, Washington, just too late for inclusion in the symposium on air diffusers published in *Engineering News* of July 13, 1916. In substance, Mr. Frank says:

> During May and June the umbrella-shaped diffuser grid was lifted out of the tank and 60 new filtros disks clamped into place, thus doubling the diffuser area. At the same time the old disks were carefully removed, washed and replaced. The old plates showed evidence of disintegration. Some of them were distinctly more crumbly than the new ones, and many of the old plates were cracked. The only explanation of this possible disintegration thus far offered is the alkalinity of the sewage. It should be noted that the old and the new disks represented two widely separated shipments and that the old disks may have been inferior to the new ones in manufacture.

Two views of the umbrella-shaped grid at Baltimore were printed on p. 800 of *Engineering News* of Apr. 27, 1916.

It may be added that owing to difficulties with the air blower at Baltimore the activated-sludge tank there had been out of commission for several weeks when Mr. Frank sent (July 14) the information given above.

The Garbage and Refuse Incinerator at Savannah, Ga., burned 27,661 tons of mixed refuse during 1915, at a total cost of $21,564. This sum was divided as follows: Incinerator operation, $17,084; weighing refuse and delivery of same to the hoppers, $1,556; maintenance, including outlays, $2,924. Deducting from the total cost the sum of $4,800 for steam furnished to the water-works pumping station leaves a net total cost of $16,764, or 59.7c. per ton. The destructor is of the high-temperature Heenan-Froude type and was completed in March, 1914, by the Destructor Co., New York City.

Field and Office

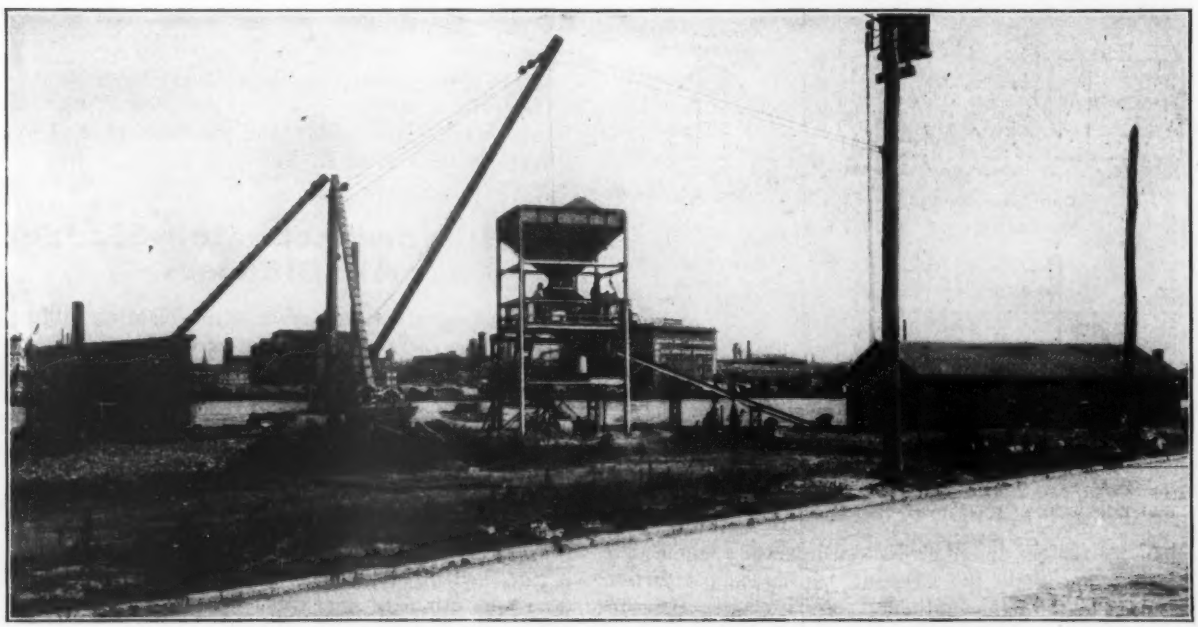
Central Concrete-Mixing Plant Tried at Baltimore

By G. Y. Carpenter*

A unique attempt to demonstrate the practicability of mixing concrete at a central plant and distributing it where required anywhere over a fairly large area was tried out in Baltimore, Md., last fall. In the opinion of the writer the feasibility of such a scheme was demonstrated, but certain limitations of capital prevented the construction of a working plant, or at least of the turning of the experimental plant into a working plant.

The company, incorporated in May, 1915, proposed to construct a plant that would supply wet mixed concrete of any proportion at a fixed price at the plant or delivered, at prices depending on the length of haul. It was necessary, before proceeding, to secure the approval of the city engineering department, inasmuch as it was expected that a great deal of the work would be on city jobs. The method later to be described was approved by that department. It was pointed out that by maintaining a system of inspection at the point of mixing, it would be unnecessary to place inspectors at all points of the city where concrete was being used, and further that the grade of concrete furnished would far surpass in every respect that secured by a hastily formed organization on the various jobs. In addition to this, there would be no litter in the streets, such as is inevitable where large or small quantities of raw materials are assembled for concrete work. The finished product passing from motor truck directly into the forms, where the elevation was sufficient, or to subgrade in the case of paving or sidewalk work, or quickly wheeled in barrows to the point of final deposition from a dumping board, would remove all the local evidences of concrete mixing.

The time agreed upon for transportation of the wet mixture was not to exceed in any case 30 min., a period ample for covering a very large area where motor trucks are used. In support of the safety of this time limit against deterioration of material due to initial set, some tests were carried out by the Richard K. Meade Laboratory in Baltimore, which showed that the jiggling of mortar for periods up to an hour and a half did not materially decrease the strength of the mortar so treated; in fact, a small amount of such shaking seemed beneficial.



CONCRETE PLANT AT FOOT OF HUGHES ST., BALTIMORE, FROM WHICH CONCRETE WAS DELIVERED FOR SALE

As a location as near as possible the center of the city was necessary in order to compete with delivered prices on raw materials, a site owned by the city on the waterfront was selected. This property is very near the actual center of Baltimore. As it had a short time before been equipped with a new dock, it was thought admirable for the point of distribution. Accordingly, a plant designed especially for this particular operation by the Ransome Concrete Machinery Co., of New Jersey, was erected. This entire plant, including that furnished by the above company, consisted of an office and cement-storage building, a steel-frame tower containing the equipment for mixing, an industrial railway for handling cement, a three-drum engine with stiff-leg derrick and half-yard clamshell bucket. The mixing tower contained a separated bin at the top for sand and gravel and on

*Estimating Engineer, Building Supplies Corporation, Norfolk, Va.

two platforms, one above the other and below the bin, the proportioning hoppers and the mixing drum of 1-yd. capacity. Gates operated by levers were provided at the bin bottoms and at the hoppers to accomplish quick movement of the materials downward. The complete plant, with the exception of the hoisting engine, was driven by electricity. It is shown in the accompanying view.

The aim of the company was to eliminate all handling of materials by manual labor and to perform the operations of charging the drum and discharging the mixed concrete into trucks entirely by gravity. A further advantage was that, being on the waterfront, sand, gravel and cement were bought in scow-load lots f.o.b. plant and were unloaded, with the exception of cement, which was trucked directly into the warehouse at a very low cost per barrel. Sack loss was unknown here, as the car returning from the mixing tower always brought back the empty sacks, which were unloaded in the warehouse a short time after they were emptied.

The first work undertaken after the plant was ready for operation was a number of sidewalk contracts. For the protection of the consumer an inspector was stationed at the plant, who approved the mixture and stamped with the hour and minute of departure of trucks a ticket carried by the driver and presented on arrival of his load to the receiving agent. As the time for transporting was set by the city at 30 min. maximum, all concrete arriving as shown by the delivery ticket within that time was accepted, and all exceeding that time was rejected. This was part of the agreement under which the material was sold. It is significant that during the entire time of operation not a single truckload of material supplied under the above conditions was rejected.

As it became known that concrete could be obtained in a wet mixed condition, a variety of uses developed. In one instance it was supplied in bags delivered to the job and elevated by means of a dumbwaiter to the third floor of a restaurant, where it was used to construct a concrete floor. In this case water was added on the job. Among the more important types of construction handled was a part of the Eastern pumping station for the city, involving a haul of five miles. In all cases the material was dumped directly into chutes leading to forms or was placed from a dumping board with barrows.

The organization of the company consisted of a manager at $100 per month, a hoisting engineer at $20 per week, three laborers at $12 per week, a fireman at $12 per week and a bookkeeper at $75 per month. The hauling equipment was made up of motor trucks of the regular contractors' hydraulic-dump-body type. They were found fast enough to handle all material easily within the limit of time. They also gave no trouble with concrete sticking to the body.

So far as the writer at this time knows, the work done was satisfactory in every way, and it is his opinion that such a plant, operated in strict accordance with the methods adopted from data gained after a few days' running, will in time come in all cities where concrete is used. On account of lack of capital, operation was not resumed this season, and it is thought by some that a certain antagonism on the part of the contractors prevented further financing.

The company operating the plant was the Baltimore Concrete Placing Co., of which the writer was vice-president.

Steam-Jacketed Forms for Winter Concreting

An unusual piece of winter concreting was done on the Baltimore & Ohio R.R., one mile east of Paw Paw station, W. Va. This job is a small element in building the Magnolia cutoff on the Cumberland, Md., division. Concreting was done by means of a large steel derrick

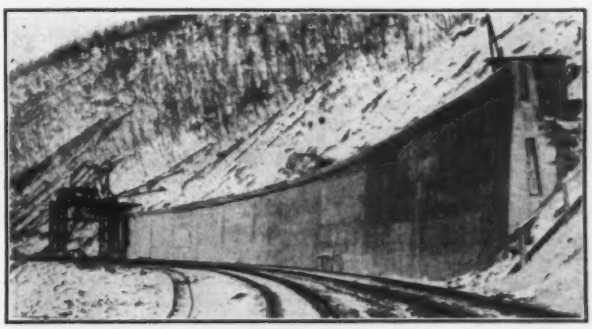
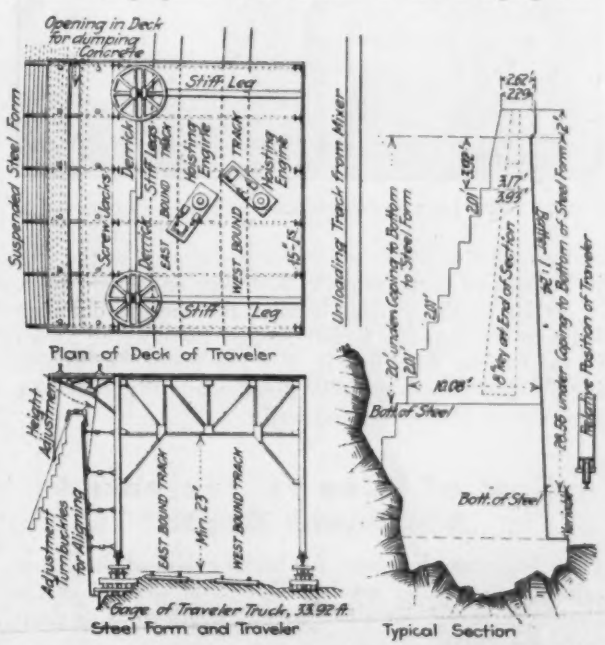


FIG. 1. VIEW OF PAW PAW RETAINING WALL, WITH STEEL TRAVELER AT WORK AT FAR END

traveler which was fully described in a comprehensive article by Francis Lee Stuart, the then Chief Engineer of the road, in *Engineering News* of June 29, p. 1218.

The sand and crushed stone used in making the wall concrete were heated by diffusion of steam from perforations in a coil of 2-in. pipe placed at the bottom of the storage piles. The bottoms of the charging bins



FIGS. 2 TO 4. SKETCHES OF FORM-TRAVELER AND WALL
Fig. 2—Deck of traveler. Fig. 3—Steel form and traveler. Fig. 4—Cross-section of wall

above the mixer also were fitted with perforated piping so that the heat might be retained in the materials.

The water used in mixing was maintained at about 100° F. by a live-steam jet discharging at the bottom of a 3,000-gal. tank or reservoir kept constantly full. The overflow from this tank discharged into a 50-gal. measuring barrel, being heated to scalding temperature by another jet of superheated steam.

The wall forms were insulated with straw and plank on the back and covered with tongue-and-grooved flooring on the face, retaining a 2-in. space between the steel and the wood through which low-pressure steam from one of the boilers on the deck of the traveler was diffused by a perforated 1-in. pipe. This pipe was at the bottom of the form and ran longitudinally the entire length, connecting with the boiler by a T-connection and vertical pipe at about the middle of the section.

A stationary mixing plant was installed adjacent to the main line of the railway, about a half-mile west

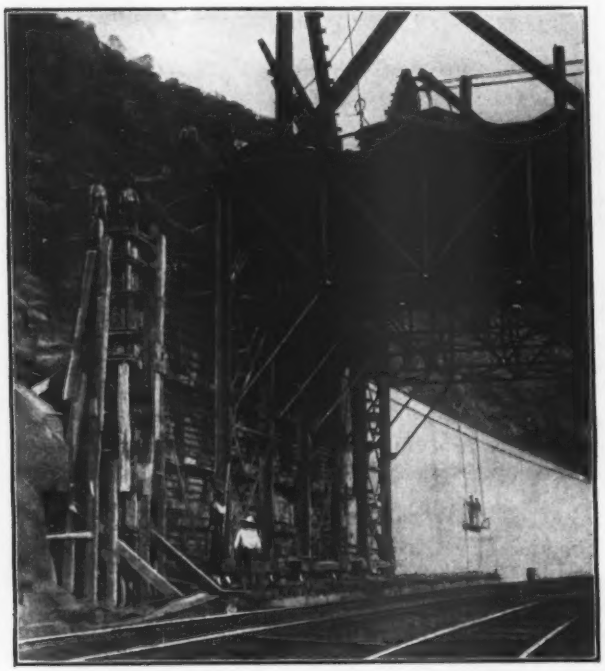


FIG. 5. VIEW OF TRAVELER AND STEAM-HEATED FORM

of the wall site. The concrete was conveyed to the wall in buckets on cars drawn by a dinkey on narrow gage. A derrick on the traveler handled the buckets, dumping the concrete into the forms through the opening shown in the traveler floor in Fig. 2. The method of attaching the steel form is given in Fig. 3, while Fig. 4 shows a cross-section of traveler and wall.

Cost of Piles vs. Increased Abutment Depth*

In designing abutments for bridges the question often arises as to whether wood piling should be used or the abutment carried down to a greater depth so as to eliminate the piling.

If the difference is more than 2 ft. it will be found that piling will prove cheaper in almost every case. In order to show this more clearly we will consider a typical case of a 30-ft. standard plan on reinforced-concrete abutments.

If piles are used the abutments will have to be 14 ft. high while if the piles are omitted and the concrete is carried down to solid bearing a height of 17 ft. will be required. The higher abutments contain 25 cu.yd. more concrete and 3,160 lb. more reinforcing than the 14-ft. abutments, which extras would cost about $470.

The cost of 32 wood piles 20 ft. long would be about $320.

This shows an estimated saving of $150 by the use of timber piling and in all probability the saving would be even greater, as no attention has been paid to the fact that the deeper excavation would be more expensive and therefore would increase the unit cost of the 17-ft. abutment.

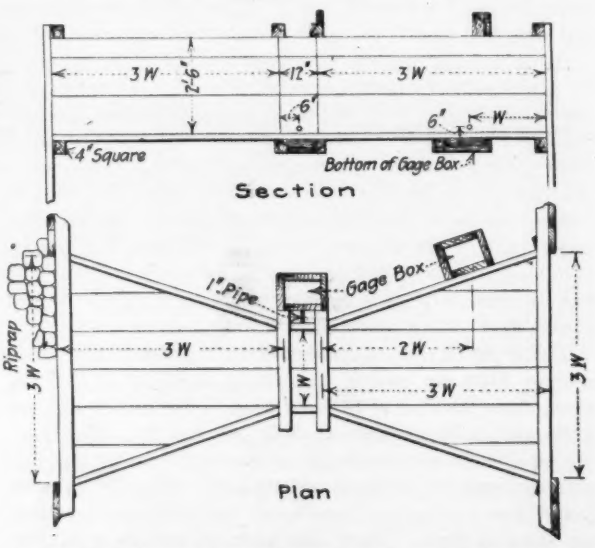
In addition to economy there remain to be considered the relative merits of the two structures. The abutment on wood piling should be better in every respect, as it is almost impossible for it to be washed out or in any way injured by high water. The abutment without piling would have to go to a considerable depth below water, which would make it difficult to properly place the steel in the footings and lower part of the wall.

Taking everything into consideration, the abutment with piling is in almost every way superior to the one resting merely on earth or gravel foundation.

*From "Minnesota Highway Journal," July, 1916.

New Measuring Flume

Experiments made in the hydraulic laboratory operated at Fort Collins, Colo., by the Office of Public Roads and Rural Engineering, United States Department of Agriculture, and the Colorado Experiment Station (see *Engineering News*, Oct. 2, 1913, for description of laboratory) have resulted in the development of a measuring flume which the experimenters believe promises to



VENTURI FLUME DEVELOPED BY U. S. DEPARTMENT OF AGRICULTURE

overcome the chief difficulties experienced in measuring water for irrigation purposes. The action of the device depends upon the adaptation of Venturi's principle to the flow of water in an open channel. The chief features of the device are shown in the accompanying sketch. The sides of the converging, throat, and diverging sections of the flume shown in the plan are vertical and the floor is level and at the same elevation as the bottom of the ditch. For smaller ditches a V-shaped throat having side slopes of 1 on ½, a top width of 1½ ft. and a length of 1 ft., is set between approach and outlet flumes 3 ft. long and

having bottom widths tapering from 2 ft. to zero. For large ditches there is a flume of trapezoidal cross-section with side slopes of 1 on 1½, bottom widths tapering from *W* (bottom throat width) to 3 *W* at a distance of 3 *W*. The throat is 1 ft. long.

The laboratory tests thus far made indicate that the device is quite accurate in its measurements. Additional laboratory tests are being made during the present season. Larger flumes have also been installed under field conditions and will be calibrated and tested.

The Venturi flume is inexpensive and easily constructed and maintained. It automatically takes care of the velocity of approach and requires but little loss of head in the ditch. The increased velocity in the throat greatly reduces the danger of trouble from silt, sand, aquatic growth or floating trash. The discharge through the flume is dependent upon the depth of water in the throat or the diverging section as well as upon the difference of depths. The depths are easily measured in the gage boxes and the discharges may be ascertained from tables or diagrams.

V. M. Cone, who has charge of the Fort Collins laboratory, and his assistants feel confident that the device which they have developed possesses sufficient merit to warrant making thorough tests.

Long Distance Haulage with Motor Trucks

Experience with two 3½-ton motor trucks in mine haulage between Shultz and Tucson, Ariz. (47½ mi.), is given in a paper for the September meeting of the American Institute of Mining Engineers and now printed in the "Proceedings." One truck was fitted with a 1,075-gal. oil tank and used for carrying "tops." The other had a stake body and was used for hauling machinery, rails, pipe and miscellaneous supplies.

There were no excessive grades, but the roads were very bad for three months and never were good. The trucks were not run in wet weather—unless out on the road when rain started—for they were likely to stick in the mud. The lost time was about 5% of the total. Rubber tires were used throughout. Gasoline cost from 17 to 21c. per gal. Drivers got $4.50 to $5 per shift. The total cost of haulage was $12 per ton, compared with $15 as the best possible team price. The appended table covers the time from Aug. 21, 1913, to Aug. 15, 1914, when the trucks were in continuous service. From then to Mar. 30, 1916, the trucks were used only intermittently.

RESULTS OF MOTOR-TRUCK OPERATION BETWEEN TUCSON AND SHULTZ, ARIZ.; AUG. 21, 1913 TO AUG. 15, 1914

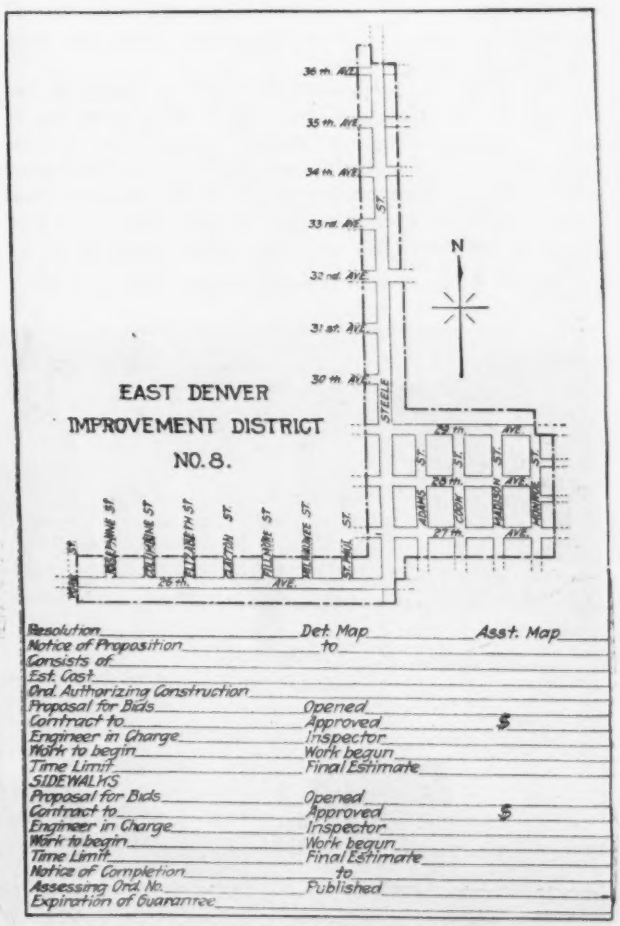
Total distance traveled, miles	23,000
Total work done, ton-miles	42,700
Average distance per gallon of gasoline, miles	4.5
Average distance per gallon of lubricating oil, miles	128
Average speed, loaded, miles per hour	7
Average speed, light, miles per hour	7.8

	Total Cost	% of Total	Per Truck-Mile	Per Ton-Mile
Wages of drivers	$2,623.32	23.91	$0.1141	$0.0614
Wages of helpers	286.50	2.62	.0125	.0067
Repairs, labor	581.74	5.30	.0253	.0136
Repairs, lost time	156.15	1.42	.0068	.0037
Oils, grease and waste	379.17	3.46	.0165	.0089
Gasoline	1,610.49	14.68	.0700	.0377
Tires	2,445.75	22.30	.1063	.0573
New parts	515.08	4.69	.0224	.0121
Miscellaneous supplies	348.82	3.18	.0152	.0082
Incidental expense	226.21	2.06	.0098	.0053
Depreciation	1,796.80	16.38	.0781	.0421
Total	$10,970.03	100.00	$0.4770	$0.2570

Pavement Construction Records at Denver, Colorado

The method of keeping records of pavement construction and incidental data in Denver, Colo., is as follows: A miniature map of the improvement district is plotted to such scale as to fit a 9x10½-in. sheet of tracing cloth. This and a standard form, as shown in the accompanying illustration, are printed simultaneously on a sheet of cloth-backed blueprint paper approximately 12x16 in. The blank spaces are then filled in consecutively as the work progresses.

The first line gives the date of the resolution of the council from which the work originates; the file number



METHOD OF KEEPING CONSTRUCTION DATA ON PAVEMENTS, DENVER, COLO.

of the detail map or plan and the file number of the assessment map. The second line gives the dates when the resolution was published and the date of last protest. Printed clippings or copies of the resolution, authorizing ordinance and proposal for bids are kept in a bound scrap book, properly indexed so as to be readily accessible at all times.

These cloth-backed blueprints are bound in books—one book for all work in progress, and a book for each year of completed work. Similar books are kept for sewer improvements. The page alone gives most of the data in general demand, and it serves also as an index to information filed in other places.

The city engineer of Denver is H. F. Meryweather.

Cable System Handles Dump Wagons on Heavy Grades

By James Owen*

Old Dobbin, in these days of the efficient and fast-moving motor truck, is being rapidly crowded from urban grading jobs. Once in a while, however, through some mechanical aid he is enabled to cope with this modern mechanical wonder. This article has to do with just such a case. Briefly, the work performed was the hauling of rock in 2-yd. Troy wagons up a 16.5% grade, by means of an auxiliary cable—attached to the wagon—which made the load handled by the team almost negligible. Connecting this same arrangement of cable on another part of the work allowed the team to descend a 28.75% grade without setting the brakes and with comparative ease.

This ingenious method of handling the material was evolved by Al. Hennessy, the outside superintendent of the Federal Construction Co., and was used on a grading job that this firm had been awarded in San Francisco. The work was done under public contract under a two-year installment plan, at a total cost of $39,517.55, and involved moving 58,677 cu.yd. of material, of which 13,087 yd. was in slope. The contract was completed June 13, 1916.

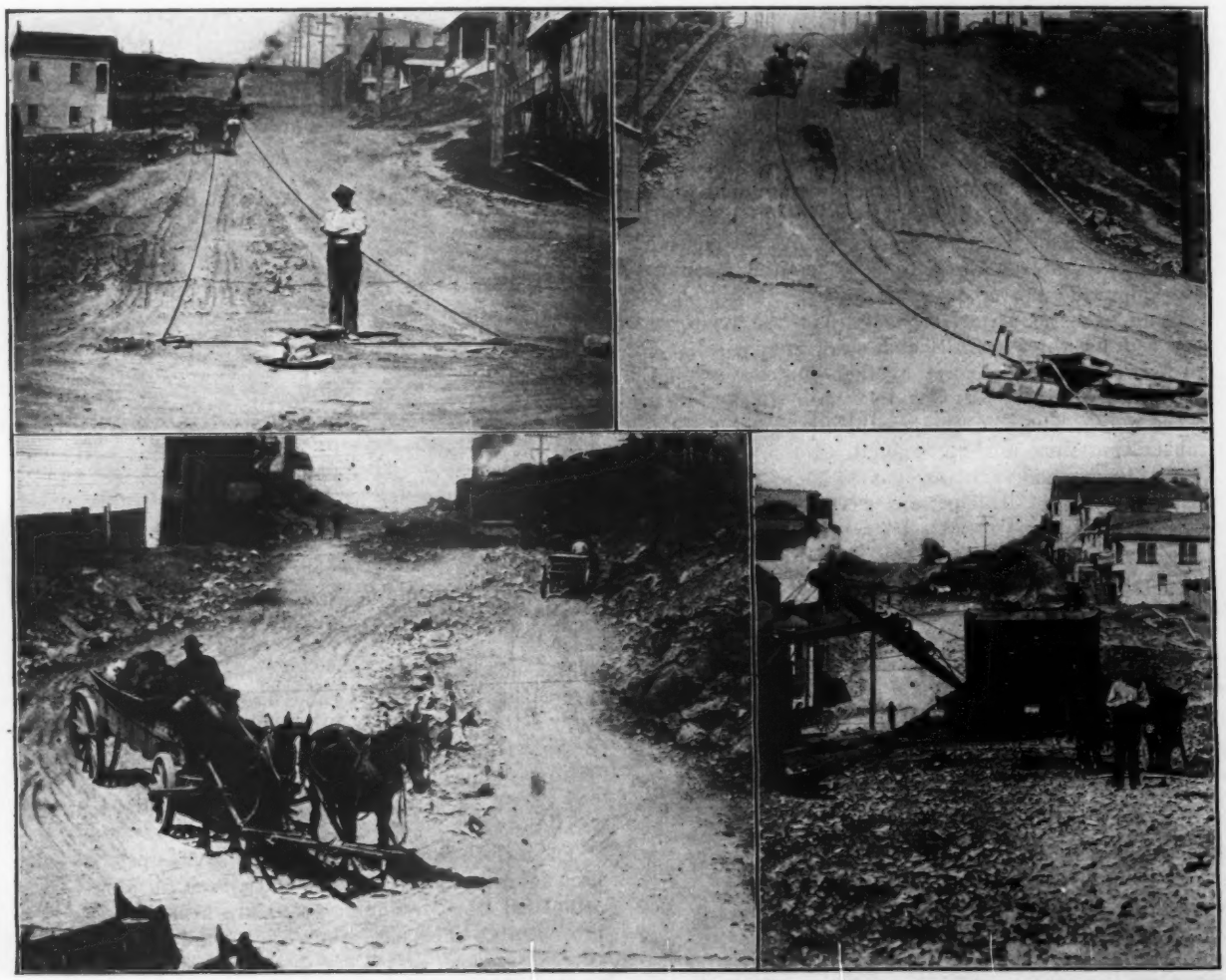
Owing to the peculiar topography of this district (see views), some such method of handling the material as was adopted was necessary in order to show profit. Fortunately, a short haul was available, the contractors having made arrangements with the owners to fill some of the low land adjacent to the streets graded. On Vermont St., some very heavy fills were made, necessitating raising a number of houses to the new grade.

Using the method herein described, the contractors were enabled to make the fill at small expense to themselves. The sketch (Fig. 5) shows in detail how the material was handled.

A small donkey engine (with engineer and helper), a few hundred feet of ½-in. wire cable with hooks attached, and several deadmen and pulleys were all the extra equipment necessary.

Near-by, another grading job was in progress, under the supervision of the city, on which 5-yd. motor trucks were used. The haul, however, was much longer, and consequently the cost was much greater. It afforded a good opportunity to compare the two methods, as both jobs were in plain sight from the high ground. It was impracticable to use cars on account of the steepness of

*Assistant City Engineer, San Francisco, Calif.



FIGS. 1 TO 4. GENERAL VIEWS OF GRADING WORK ON WHICH EXTENSIVE SNATCH SYSTEM WAS EMPLOYED BY CONTRACTOR

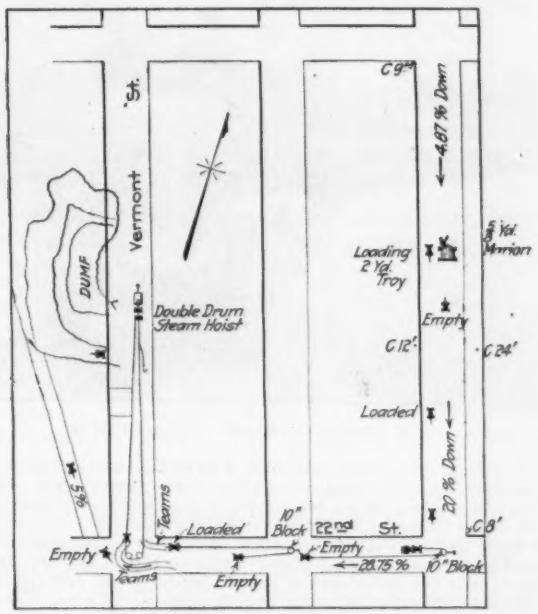


FIG. 5. LAYOUT OF CABLE SYSTEM DEVISED BY SAN FRANCISCO PAVING CONTRACTOR

the grades. The following cost data were supplied by Mr. Hennessy:

Shovel Crew:	Per Day
1 foreman	$4.50
1 engineer	6.75
2 firemen	7.70
2 pitmen	5.00
	$23.95
Estimated depreciation on steam shovel	10.00
20 sacks of coal @ 50c	10.00
3 flagmen @ $2.50	7.50
2 dumpmen @ $2.50	5.00
6 drillers @ $2.50	15.00
	$71.45
12 teams @ $6	72.00
	$143.45

10 teams, 24 loads each = 240 loads, or 480 cu.yd.
2 snap teams.

12 teams, averaging 20 loads each per day = 240 loads.
480 cu.yd.—$143.45—$0.2984 per yd.

Summary:	Per Cu.Yd.
Superintendent's rates, 480 cu.yd. @ $4.50 per day	$0.0094
Loading shovel, 480 cu.yd. @ $39.45 per day	0.082
Teaming, dumping, etc., 480 cu.yd. @ $84.50 per da	0.176
Drilling, etc., 480 cu.yd. @ $15 per day	0.031
	$0.2984
Powder	0.06
Average cost per cu.yd	$0.3584

The four views illustrate particularly the handling of the material. Fig. 1, on Vermont St., shows a wagon being assisted up a 16.5% grade to the side dump where most of the fill was made. Fig. 2 shows 22nd St., south of Rhode Island St. The gradient on this block is 28.75%; the cleated walk at the west indicates the steepness of the grade. A cable block is illustrated. Fig. 3 is on Carolina St., looking east from 22nd, and shows the steam shovel at work. Notice the wagon with chain attached to the rear axle—this chain was attached to a hook on the cable. Fig. 4 is on Carolina St., looking east from a point south of 22nd, and shows a second steam shovel at work.

Sprinkling 294 Mi. of Streets in St. Paul, Minn., during the season of 1915 took 254,248,000 gal. of water. This is equivalent to 9 in. of rainfall over the area sprinkled.

Unit Stresses for Timber; Manufacturers' Table

The technical bureau of the National Lumber Manufacturers' Association, Chicago, has prepared a new table of recommended working stresses for structural timbers in dry locations. This table, reproduced herewith, is based on data furnished by the Forest Products Laboratory, Madison, Wis. The values given for "Dense" Douglas fir and yellow pine are subject to limitation of size and location of knots and other defects, as under most current specifications.

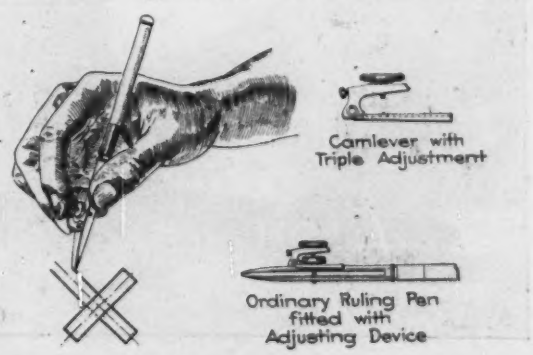
WORKING UNIT STRESSES FOR STRUCTURAL TIMBERS USED IN DRY LOCATIONS

	Bending		Compression	
Species of Timber	Stress in Extreme Fiber, Lb. per Sq.In.	Horizontal Shear Stress, Lb. per Sq.In.	Parallel to Grain "Short Columns," Lb. per Sq.In.	Perpendicular to Grain, Lb. per Sq.In.
Fir, Douglas:				
Dense grade	1,600	100	1,200	350
Sound grade	1,300	85	900	300
Hemlock, Eastern	1,000	70	700	300
Hemlock, Western	1,300	75	900	300
Oak	1,400	125	900	400
Pine, Eastern White	900	80	700	250
Pine, Norway	1,100	85	800	300
Pine, Southern Yellow:				
Dense grade	1,600	125	1,200	350
Sound grade	1,300	85	900	300
Spruce	900	70	600	200
Tamarack	1,200	95	900	350

Ruling Pen Rapidly Adjustable for Heavy or Fine Lines

A practice quite general in tracing intricate drawings in drafting rooms is to trace in the heavy lines first and then insert the fine and dotted lines, or vice versa. By this method the draftsman must go over the entire drawing a number of times and must adjust the T-square and triangle twice before a line composed of heavy and fine parts can be completed. In inking in fine lines exclusively it frequently happens that the ink will not run freely, dries in the pen and forms a crust that can be removed only by cleaning. As a result of the two conditions stated, tracing is a slow and tedious process disliked by many draftsmen.

To overcome these disadvantages, A. E. Norrman, of Portland, Maine, has developed what he calls an "automatic multiple adjusting" pen. As shown by the sketch, the new pen consists of a detachable adjusting device that can be attached easily to any standard drawing pen, thereby enabling an automatic adjustment of the pen for lines of three different thicknesses. The adjustments are accomplished by manipulating a small cam lever that acts on the upper blade, and the details of the de-



MULTIPLE ADJUSTABLE DRAFTING PEN INVENTED BY A. E. NORRMAN

vice are made so that the handling of the pen will become natural in the position of the pen for correct drafting. The inventor describes the action of the pen, which is not yet upon the market, as follows:

With the adjusting device in its inoperative position the pen will draw a heavy line that can be adjusted as usual. If pressure is applied on the head of the large adjusting screw of the adjusting device, the pen will draw a fine line that can be adjusted by means of the large screw. As soon as the pressure is removed, the spring action of the blades of the pen will bring the pen back into the former adjustment again. If the cam lever is brought into a position where the small adjusting screw in the rear of the cam lever rests on the upper blade, the pen will also draw a fine line that can be adjusted by means of the small adjusting screw. This adjustment will be self-locked by the spring action of the blades, and the pen draws a fine line as long as the cam lever remains in said position.

The combination of the self-releasing and the self-locking adjustment is a most valuable feature of the invention. It is desirable in drafting that the adjustment of the pen from heavy to fine and vice versa should be accomplished in minimum time, in order to draw lines that appear partly heavy and partly fine. In this case the self-releasing adjustment should be used, as it requires a motion of only some few hundredths of an inch for the adjustment. In drawing fine lines exclusively it is not always possible or convenient to exert the required pressure on the head of the large adjusting screw, and in this case the self-locking adjustment should be used, as it does not require any further effort on the part of the user.

In using a multiple adjusting pen the draftsman can proceed systematically with his work. He can now, instead of searching all over the drawing for lines of the particular thickness for which his pen happens to be set, confine his attention to one part of the drawing, tracing in full lines, dotted lines and fine lines as he proceeds from one part of the drawing to the other.

In constantly changing the automatic adjustments of the pen the crust that forms in the drying of the ink will be broken up, and actual experience has shown that the ink will run freely and the various lines be of the same uniform thicknesses whether the pen is full of ink or nearly empty.

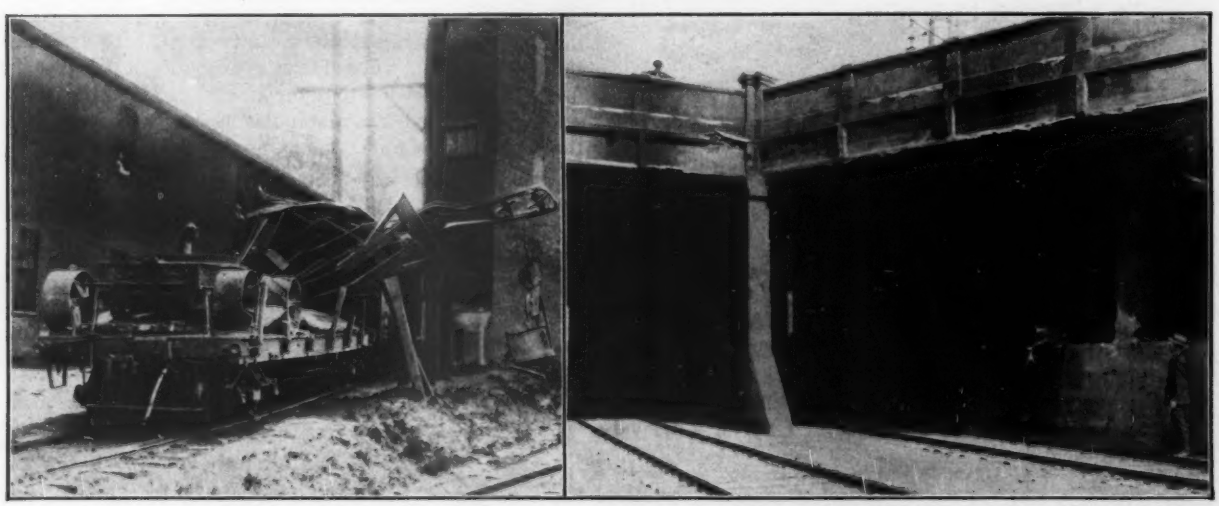
NOTES

A 3-Ton Truck Hauls 26 Tons of Crushed Rock—A "Four-Wheel-Drive" truck is used in place of a dinkey to haul a string of 1½-yd. dump-cars running on narrow gage by the Hanlin & Oakes Co., contractor, of Sioux City, Iowa. The truck straddles the rails, as shown in the view, and according to a statement of the Four Wheel Drive Auto Co., of Clintonville, Wis., the train shown can go up a 5% grade, no load being carried on the body of the truck. The crushed rock, gravel and cement hauled by this outfit are being used in the construction of a 16-ft. concrete highway going north from Sioux City on what is known as the Perry Creek road. It is stated that from 500 to 600 lin.ft. of pavement is being laid daily. The material track is 4 mi. long, and 10 round trips are made daily. The truck pulls a load of 24 to 26 tons while running in high gear and travels at 12 to 15 mi. per hr. It is claimed that the daily cost of operating the truck and trailers in this service is $17.

A 3-TON TRUCK SERVING AS A DINKEY

Cost of Operating Motor Road Oiler—The City of St. Paul, Minn., has a 1,000-gal. "Good Roads" motor-truck road oiler. The machine is equipped with a kerosene heater and hot-water coils in the tank. The air pump is operated from the main drive shaft. The machine spreads oil to a width of 14 ft. As an average day's work under ordinary conditions the machine made the following record: Roadway oiled streets, 3,960 lin. ft. 24 ft. wide and 2,296 lin.ft. 16 ft. wide, in one 8-hr. day, or approximately 14,700 sq.yd.; 2,700 gal. of oil were spread, or 0.19 gal. per sq.yd.; 15 gal. of gasoline were used and the distance from the storage tanks to the streets oiled was 5 mi. Three trips were made. Two men, a chauffeur at $85 per mo. and an operator at $2.50 per day, were required. The machine cost $6,700 and does the work of five 600-gal. horse-drawn tanks. The weight of the machine empty is 7½ tons and loaded 11½ tons. The total unit cost of labor and material averages about 1c. per sq.yd. These statistics are from the city records.

Combat Between Steam Shovel and Bridge—The steam shovel as built today is expected to bear imperturbably a fall of rock following a blast. It is, in fact, one of the most rugged of contractors' machines. It is not, however, invulnerable—that fact was established recently in Cleveland, when a Thew automatic, loaded on a flat-car, worked loose and struck a concrete-incased steel bridge as the train passed under. Fig. 1 shows the remains of the shovel; Fig. 2, the scarcely damaged bridge.



FIGS. 1 AND 2. SHOWING THE THEW SHOVEL AND THE DETROIT AVE. BRIDGE OVER THE NICKEL PLATE R.R. IN CLEVELAND

Editorials

Safeguarding Large Cities from Explosion Disasters

The disastrous explosion of July 30 at New York City has brought forcibly to public attention the matter of safeguarding cities from disasters due to the accidental discharge of large quantities of explosives. This explosion was probably the most widespread disaster caused by the accidental discharge of explosives that has ever occurred in the United States. The loss of life was astonishingly small, only a half-dozen persons in all, owing to the fact that the explosion occurred at 2 a.m. on a Sunday morning, the time when working forces are at their minimum.

The property damage was very great, however, not only in the immediate vicinity of the explosion, but over a radius of nearly half a dozen miles. Besides the loss of life and property there was an unmeasurable nervous shock to millions of people awakened from a second sleep throughout greater New York, its suburbs and outlying districts for many miles in three states. Most of these people were filled with vague alarms and thousands were panic stricken. Were it possible to measure the waste of vital energy caused by the explosion it might prove to be the most serious aspect of the disaster.

It is evident that both the City and the State of New York are powerless to protect themselves against dangers that may be created across the state boundary in New Jersey. The authorities of Jersey City, however, promptly enacted an ordinance forbidding the transport of cars loaded with explosives on any railway entering the city and placed a force of 125 policemen at the municipal boundaries to stop all freight trains and prevent the entrance of any having explosive-laden cars. Perhaps the Federal courts will act to prevent this interference with interstate commerce; but the intent, at least, of the ordinance is sound—to stop the handling and storage of large quantities of explosive material in the vicinity of a densely populated city. The municipal ordinances in New Jersey previously prohibited the storage of explosives in any considerable quantity and required that explosives brought in by train during the day shall be transferred to lighters and taken away before nightfall, but there is always a chance that some interruption or other to traffic will cause an accumulation of freight. It is claimed that the explosive-laden lighter that caused the chief destruction should have gone down to Gravesend Bay before nightfall, but instead remained at the pier over night.

The operation of a large powder factory close to New York City would not be permitted, and neither should the transport and handling of great quantities of explosives in such a location be allowed. Explosives at the Port of New York, for example, could readily be handled from cars to boats at Perth Amboy, which is at the head of Raritan Bay and over 20 mi. distant from New York and the large cities across the Hudson in New Jersey. At other cities also where large quantities of explosives are handled the same principle of diverting the shipments to the outskirts should be applied. The carrying out of such a plan would probably have to be done through the Bureau of Explosives of the Interstate Commerce Commission. It is manifestly impossible for cities to exercise authority outside their own borders, and, as the New York situation shows, state action may be similarly hampered. Federal authority over interstate commerce is complete, however, and the splendid success attained by the Bureau of Explosives under Col. B. W. Dunn makes it probable that there would be general acquiescence in the proposal to extend the scope of his bureau to cover storage, transshipment and water transportation of explosives as well as handling on railway lines.

How To Apply for a Job

The interesting paper by R. Fleming in *Engineering News* of June 8, giving hints to the engineer about what to do and what not to do when he writes a letter applying for a position, is followed in the present issue by a paper by C. A. Bock, Secretary of the Morgan Engineering Companies, summarizing his experience in examining some 3,000 applications for engineering positions.

It is unfortunate that the ability to write a first-rate letter of application for a position is very often lacking in engineers who have had a large amount of experience and are entirely competent in their special field. This is particularly apt to be the case with an engineer who has held one position for a long time and who, when some business change makes a search for a new position necessary, is at a loss how to go about it. The chances are that his letter of application to a prospective employer will be inferior to the one written by the happy-go-lucky chap who, because of something or other lacking in his makeup, seldom lasts longer than six months in a place, and as a result has a large experience in writing letters for a job.

Mr. Bock's suggestions, therefore, are likely to be found useful, not only by the large crop of June graduates of the present year, whom he mentions in his opening paragraph, but by many engineers of experience and high standing.

It occurs to us, in this connection, to add to those given by Mr. Bock, another useful hint that we happen to know has been found helpful by many engineers inexperienced in going about the task of seeking a position. Our suggestion is that the engineer who is seeking a position should prepare a letter setting forth in fairly complete form just what his professional experience has been, including in this, of course, a statement as to his education and personal characteristics, such as a prospective employer would desire to have. A list of references, stating in connection with each reference just what particular part of the applicant's experience or characteristics it treats of, should also accompany the letter.

This statement should be neatly typewritten on good paper of standard letter size, and a copy can then be inclosed with any letter of application or reply to an advertisement. In this way the letter of application itself

can be made brief and businesslike, and can emphasize any special fitness which the writer may think he possesses for filling the particular position to which the letter relates. At the same time the employer is given all the facts concerning the applicant that he is likely to need, in a form where they are readily filed for examination.

There is another advantage in thus carefully preparing a statement of professional experience and personal qualifications and having copies on hand available for use when wanted. The engineer thus equipped is able to mail his application immediately for any position that may be open, whereas if he has not thus practiced preparedness, pressure of other duties may make it impossible to write promptly a good letter covering all the points, resulting in the sending of a poorly written missive in which he will not do himself justice.

Costly Maintenance Work

If anyone doubts that maintenance requires of the engineer more resource and judgment than does construction, let him consider the case of the Radebaugh tunnel. To maintain this tunnel in safe condition required, besides observation of settlement and other deterioration, the exercise of unusually keen judgment in interpreting the conditions existing at any given moment, and ingenuity in planning feasible and economical methods of repair. The reconstruction, a work of highly individual interest, is quite beyond comparison with the routine operation of driving a short rock tunnel on new construction.

But while thinking of maintenance it is important to distinguish those cases in which continuous and uninterrupted service is the imperative consideration. The responsibility of maintenance is multiplied under this condition, and judgment must be preëminently quick and unerring. Observation must be so close that failure is foreseen a long time, and planning for repairs must be generous both as to cost and as to time. Of two methods available, the more difficult and costly must be chosen if it reduces the hazards to the service. In short, we must apply a different scale of cost to problems of maintenance in continued service from that applicable to a service which may be discontinued. And in this light the costliness of an operation like the Radebaugh tunnel work appears natural and proper.

In this particular enterprise is found a common feature of difficult maintenance problems, namely a succession of attempts at minor repair before finally heroic measures are resorted to. But in this instance even the minor operations were of notable kind. Sinking a deep shaft, for example, merely to place a small patch of new lining is decidedly out of the ordinary run; and, by the way, some moral courage was required, no doubt, in recommending so elaborate an undertaking for a little local difficulty. Of course, the final step, enveloping the whole tunnel with lining in a new shell, is practically without precedent.

Relining, widening or other repair of tunnels in service is a frequent enough problem to direct attention to the first-cost question. It is far cheaper to do work at the time of original construction than to do it later on as a reconstruction job under traffic. Putting in permanent lining, for example, has often been regarded as a luxury to be indulged in only under stress of immediate necessity; and in so many a tunnel it has become necessary to do very expensive lining or relining work afterward. Not a few tunnels, where lining was omitted in "sound" rock, are the subjects of most anxious weekly or even daily inspection to discover scaling of roof, and even so rock falls happen from time to time. The costs and risks of such a condition should be fully appreciated before resorting to money-saving practices in first construction. There are similar cases in other fields, as in bridges. Bridges have so often been designed without overload capacity, and so often have been replaced at a young age because of obsolescence, that the disadvantages of skimping design are now better recognized than they have been in the past.

A City Built Upon a Hole

Scranton, Penn., presents the unusual spectacle of a large and prosperous city built on land that is steadily being undermined. Every once in a while the people of Scranton are reminded of this fact—reminded in a forceful way, such as by having a few buildings collapse or get so near the point of collapse as to be left standing only by the grace of the Almighty; or by having humps and hollows like a Coney Island scenic railway develop over night in some of the public streets.

The astonishing things are that there has been almost no loss of life and that people are apparently indifferent to the ever present danger of death and injury from falling buildings. Thus far, school buildings, an armory and other structures in which many people congregate have all but collapsed, and yet by happy chance these things have occurred at such times or in such a way as to have entailed no loss of life.

What rights have the public, if the coal operators own the anthracite that underlies the city? That question has not been satisfactorily answered by the courts or by other public authorities. So desperate have the householders in sections of the city become that anarchism—closing of some of the mines by mob law—is hinted at if the courts continue to refuse some kind of redress. The claim is made that not even the constitutional right to life and limb is respected.

Many coal operators have undoubtedly shown an arrogance and a disregard for the public welfare that are fortunately becoming less common with "captains of industry" than formerly. In most instances their legal right to the coal is unquestioned, but not always. They have sometimes been guilty of surreptitiously removing coal from under lands to which they had no right. They have browbeaten lot owners into disposing of their mineral rights for absurdly low sums, and they have asked huge sums of property owners who tried to purchase the coal in place to protect surface improvements. They have contended that lot owners who waived their right to the coal have no recourse, that any surface improvements are made at the lot owner's risk and that they, the operators, have the legal right to destroy all value in such property.

The courts have upheld this contention on the general principle that "he who builds a house over a volcano must take the consequences." Without questioning the legal precedent for such a ruling, the injustice of it is obvious. People have bought and paid large sums for lots that are valueless without the right to build on them and valueless if buildings on them are made uninhabitable. In plain words, the coal operators or lessors have sold something that they have reserved the right subsequently to destroy

without compensation to the purchaser. Specific instances of injustice and the distressing results to small property owners are numerous. Many a laboring man has had his life's savings practically annihilated.

The problems from a humanistic point of view are pressing and complex. From an engineering point of view they are interesting and unusual, but not so difficult of solution. Subsidences like those described elsewhere in this issue show curious failures of building structures and still more curious instances where they do not fail. Changes in street grades are often radical and ultimately will mean reconstruction of both surface and subsurface street structures. There is often lateral movement enough to destroy alignment and cause strange shifts in property lines.

Left alone, the whole area would eventually readjust itself to new elevations and contours, but obviously the value of surface improvements and the danger to life and limb will not permit waiting for nature to take its course. It is no difficult engineering task to fill the old works or to replace the columns of coal with columns of masonry, but it is an expensive task, and many of the old workings would have to be reopened to make the work accessible. No one appears ready to assume the burden of expense for this undertaking.

A little refilling has been done, some by certain mine operators and some by the city, which in 1914 established a Mine Cave Bureau. Not until that time was it possible for the public to know how the mine operators were conducting their work, for they have been very careful to prevent outsiders from viewing underground conditions. Of course, the first thing to be done is what the Mine Cave Bureau is aiming to accomplish—namely, obtain an accurate survey of underground conditions. After that it will not be so easy for the operators to avoid responsibility.

In the past it has been customary to entangle matters as much as possible by a complication of leases and operating companies, so that in the case of a mine where several thousand tons of coal have been taken from under a public highway it may very likely be impossible to fix upon the mine operators responsible.

Whatever the solution of the problem of responsibility is, probably the anthracite consumers will ultimately foot the bill. The most popular proposal in Scranton is to put a tax on every ton of coal mined, the proceeds to go toward protection of the surface. Whether such a tax is established by law or the responsibility is placed on the mine operators, the result in the price of anthracite to the consumer will be practically the same.

First Aid to Highway Travelers

For the convenience of automobilists, the Public Comfort Station Bureau of 261 Broadway, New York City, which is said to be backed by various national associations, has started a campaign to provide one or more roadside waiting stations "in every city through which a main highway runs." These stations would have "sanitary toilet accommodations for men and women, containing pure and wholesome drinking water," and in hard-water localities "there would be a small water-softening apparatus for supplying soft water for automobile radiators." In addition, telephones and "other necessary electric equipment" (curling irons?) would be provided. It is comforting to know that these waiting rooms would be emergency hospitals and detective bureaus, perhaps also postal substations.

Besides caring for motorists the "comprehensive plan" of the bureau would include both landing places and parking places for aviators, with "land lights so that an aviator at night will know what state he is over, and the location above the state"—whatever the last clause may mean. City public comfort stations of the sort described are estimated to cost $10,000 each, but less expensive stations for small cities and towns are proposed. Cities would build the stations, it is said, and recover the whole cost in ten years by charging a use fee. The stations would therefore be, "not a charge upon the community, but a good paying investment in dollars, decency and health."

Although not so stated in the announcement, it is reasonable to expect that when automobilists and aviators have been provided for, attention will be given to the establishment of numerous buoyed way stations where submersibles can come up to aërate and do other things appropriate to undersea craft.

Heavy Concrete Slabs Make Good Railway Bridges

Although heavy reinforced-concrete slab bridges for railway loadings have been fairly common for some years, it is doubtful if the engineering eye has yet become accustomed to their seemingly excessive thickness. The views in the first-page article this week well illustrate this. Used as we are to the comparatively thin slab supported on occasional girders, either of steel or concrete, the 20 to 40 in. concrete slab bridge seems unduly heavy to span an opening. It looks like a piece of pier footing strangely displaced from bottom to top of the structure and misapplied to the support of the light loads of traffic.

This uneasiness is of course entirely ocular, for the reinforced-concrete slab of a great depth is a most economical bridge span for heavy loads. Particularly when adapted to the unit system it has proved a valuable addition to the standard railway structures. In this form it possesses all of the known virtues of precast construction—that is, insured inspection and adaptability of time, working place and personnel—and at the same time it permits of great standardization of design for the many small crossings which railways require. In grade-crossing work it is of great value, because the abutments may be put in without interference with the street traffic and the slabs, cast anywhere convenient along the line, can be brought in and readily swung into place with a locomotive crane. When so placed its solidity permits of track work of the best type and its rigidity assures the permanence and the easy riding characteristic of main-line track.

A further advantage, which has been utilized on the Wabash work noted above and also on the Lackawanna grade crossings outside of New York City is the case with which skew spans can be built. Form work for such skews is hardly more expensive than for a straight span and the piling up of one slab alongside or even on top of another is equally easy. This simplicity of form work, in fact, is the main factor in the economy of this useful structure.

Letters to the Editor

Standard Asphalt Specification Should Be Adopted

Sir—An editorial in *Engineering News* of July 27, under the caption "Repetitious Road Discussions," is very timely. You state that almost invariably the various papers presented at road conventions deal with elementary principles. This is quite so. In the future the subjects of discussion should deal with practical details rather than in glittering generalities.

For instance, the asphalt industry would probably feel grateful for some coherent effort toward specifications that would require a definite consistency of asphalt for the same type of construction. In the penetration method of road construction one locality demands an asphalt with a consistency showing a penetration of 100 to 110, and another locality in the same climate and for the same class of work requires an asphalt of a penetration of from 130 to 140.

Right here is a practical subject that might be developed at a road convention; that is, to determine what should be the proper consistency of asphalt for penetration road work. Of course, it would not be advisable to use an asphalt of the same penetration for Watertown, N. Y., as would be used at Columbia, S. C., but some uniformity could be arrived at that could be adopted for similar climatic conditions. Then again, this same disparity often occurs in defining the consistency of asphalt for sheet-asphalt and asphaltic-concrete pavements. It is true that streets for heavy traffic require a harder asphalt than those for light traffic; but there are many small cities where the traffic is relatively the same, for which some uniform or standard penetration specification for the asphalt could be developed.

The companies refining asphalt in these days are in the same position as the pickle factory—they have to produce 57 varieties. It makes it a very onerous proposition. If the consistency of asphalt for various types of pavement could be standardized, the asphalt refiner could give his customer better service in the way of shipment and could operate his refinery with much more smoothness.

It is time for road conventions to cast aside the old, hackneyed, worn-out topics and introduce subjects that really relate to the actual construction details of road building.

J. R. Draney,
Sales Manager, United States Asphalt Refining Co.
New York City, July 28, 1916.

Should Technical Societies Try To Influence Legislation?

Sir—There has been some active discussion in *Engineering News* and other technical publications recently as to whether engineering societies should take any action with reference to pending legislation that might affect the interest of engineers.

In the Philadelphia Engineers' Club the question has been brought to a head recently through the presentation of a paper by Past-President Henry Hess, at the close of which he offered a resolution to the effect that the club should not commit itself to any action with respect to any pending legislation. I quote the following extracts from his address:

> There has been growing for some time a conviction in the engineering world that engineers should and must take a place in the community in the shaping of public affairs—a place more in accord with the importance of engineering in the economic and social political affairs and life of the commonwealth.
>
> How best can engineering associations, including our Club of Philadelphia Engineers, best place their collective engineering knowledge, experience and training at the service of the community? Two ways are debatable: A stand in favor of or against direct legislation may be taken, or engineering matters affecting the community may be carefully considered and formulated to serve as a guide and basis for the formulation into laws by those more specifically fitted by experience and training in the framing of laws.
>
> Some, at least, of the great national engineering societies, some by practice and some by direct constitutional requirement, have decided to absolutely refrain from recommending or formulating laws and to limit themselves to specific engineering advice and recommendation. In so restricting themselves they have actually broadened and deepened their influence on actual legislation. They have not sought, nor do they seek, to influence legislation, and in so refraining they have actually gained a deep and beneficial influence in and for the community.
>
> A case in point that most of you are familiar with may here be cited: A number of engineers, members of the American Society of Mechanical Engineers, largely interested in steam boilers and their safe construction and use, got together a number of years ago and were constituted a special committee of that society. A code for boiler construction was evolved that, while restraining no maker of any particular type of boiler, made certain that any boiler built and used under the code was as safe as the combined experience and skill of the designing, manufacturing and operating engineers of the country could evolve.
>
> Did the engineering association that participated in this work recommend the adoption of the code as the law of the land? Many members of the committee most earnestly demanded that that should be done. Wiser counsel prevailed. The code was published simply as what it was—the crystallization of the best knowledge of the engineering profession.
>
> And what was the legislative result? Various legislatures in various states secured copies; some had the code reprinted in toto, and many used it as the basis for a revision of their boiler laws. Nowhere was the code objected to, as must inevitably have been the case had its framers worked for the adoption into law. No point was raised of a selfish motive or a selfish end to be gained for any maker of a boiler or of a boiler accessory.
>
> A number of legislatures have incorporated the code in whole or in part into organic law. Even those members who advocated the engineering societies putting themselves behind the enactment of the code into law are now agreed that what they hoped for in the interest of the public and community actually came about much sooner and more readily as a result of their confining themselves to their special domain.

It is exceedingly interesting to compare Mr. Hess' statement that the A. S. M. E. boiler code "gets itself adopted" by state legislatures, etc., without any action by the American Society of Mechanical Engineers, with Bulletin 5, just issued by the American Uniform Boiler Law Society, an organization which was formed to secure the legal adoption of the A. S. M. E. boiler code and which represents ten different groups of commercial organizations engaged in boiler manufacture and use:

Your chairman begs to report that on July 11 a meeting of the Administrative Council was held in New York; the affairs of our society were generally discussed and a campaign planned for the continuance of the work. It was decided to put in our strongest effort on the States of Connecticut, Michigan, Illinois, Minnesota, Texas, Missouri, Tennessee and Louisiana and continue our effort in New York.

The financial report showed that all bills had been paid and approximately $2,000 on hand.

The Administrative Council was continued and the request made that each section provide at least the amount of funds that were provided last year.

In our work during the past year we have given our society and the A. S. M. E. code very broad publicity and have made known our desires throughout the United States. We do not believe we are wrong in stating that there is probably not a section in the United States that has not had the boiler code placed before them and its advantages outlined to them.

From the above quotation it is evident on its face that Mr. Hess' example cited to demonstrate that an engineering society can influence legislation by merely adopting something and refraining from all publicity concerning it really proves the exact contrary.

The rapid adoption of the excellent boiler code formulated by the A. S. M. E. is due to the fact that a strong organization, backed with the funds necessary to carry on hard, steady and effective work over a broad area, has got behind the code and is making its merits known as they deserve to be known. Had nothing of the sort been done, there is no reason to doubt that the A. S. M. E. code would have been comfortably buried in the society's transactions, to remain in dust-covered repose on library shelves, and its effect on state legislation and municipal ordinances would have been nil.

The principle at stake is a broad one and ought to be clearly understood. If the members of an engineering society decide that they want to do anything concerning public questions such as legislation affecting matters in which engineers are interested, they should understand that they will be practically wasting their time if they merely deal with abstract technicalities and adopt formal resolutions. If they really want to have any vital influence on such matters in this busy world, they must not be afraid to give all possible publicity to what they say and do, and they must be willing to do the necessary work to bring their action to the notice of those who are in authority. Q. E. D.

New York, July 29, 1916.

Mr. Godfrey Defines "Unbiased"

Sir—Referring to Arthur R. Lord's letter in your issue of July 13, Mr. Lord says that I have repeatedly published statements to the effect that wall panels are never loaded. He then recites tests made that refute this: Let us see. In Transactions of the American Society of Civil Engineers, Vol. LXXVII, p. 1701, I said, "There are no recorded tests of isolated panels with the load in the square inclosed by the columns, and none on exterior panels, except where the outer edge was supported by a girder or a wall. Furthermore, there are no tests of flat-slab construction where load was placed on all panels across a building." On page 1392 of the same volume I said practically the same thing.

The Larkin building, the test of which Mr. Lord kindly invited me to witness, had deep girders in the outer walls on the floor tested. I was impressed with the care and thoroughness with which this test was made, and if Mr. Lord, or anyone else, thinks that my remarks concerning disinterested tests refer to bias in the matter of conducting the tests, he is simply mistaken. The "interested" feature of practically all of the tests made consists in the selection *by the patent owners* of the portion of the floor to be tested. They do not select, for test, an isolated panel. They do not select a row of exterior bays where there is a simple rib support on the exterior edge, and leave the next row of bays unloaded. They do not select a row of bays completely across a building and thus counteract the dishing effect that aids greatly to support loads on single bays. They do not select an upper floor where the columns are small. They do not, therefore, make a real test of their construction. The testing engineers may do their work never so carefully and conscientiously, but so long as the selection of the portion tested is along the lines just indicated, the test cannot be said to be disinterested.

To give a little history to illustrate the point. I once tested a building. The first test was made to satisfy the builder. It was on one interior bay. The result was excellent. If I had stopped there, the report would have been lovely, and I should have resented any implication that the test was biased. But in the interest of truth and the owner I went on and tested the three bays across the building. The result was failure. The first test was unbiased but it was "interested." The second test was also unbiased, but it was disinterested. The aim was purely to find out what the floor would do under legitimate loading and use. EDWARD GODFREY.

Monongahela Bank Bldg., Pittsburgh, Pa.,
July 24, 1916.

Another Electric Battleship—Contracts have recently been let for electric propulsion machinery for the U. S. S. "Tennessee," a superdreadnaught now under construction. This action may be regarded as a result of success with the U. S. collier "Jupiter" and the battleship "California." There will be in the "Tennessee" two steam-turbine electric generating units aggregating 33,000 hp. and feeding four 6,700-hp. motors, each connected to a propeller. Smaller turbine sets will drive the auxiliaries and furnish light and power throughout the ship. There will be several hundred motors, doing all work from anchor raising to steering. Electricity will be used for cooking, ice making, etc.

Legislation and Ethics in Relation to Engineering in Minnesota are included in resolutions adopted at the recent annual meeting of the Minnesota Surveyors' and Engineers' Society. It was voted that the society should coöperate in three movements to secure improved legislation: 1, Drainage—No drainage ditches should be ordered constructed under the state laws unless it is definitely shown by the engineer's survey and report that they will be of sufficient capacity to drain effectively all low, wet or marshy lands in the watershed, together with all lands from which the water is likely to be diverted thereto. 2. Water-Supply and Sewage Disposal—There should be better laws defining the powers and duties of the State Board of Health, as the present laws are inadequate to control properly water-supply and sewage disposal. The lack of competent supervision and advice is leading to practices and conditions that are liable to endanger public health and cause the wasteful expenditure of public moneys. 3. Land Surveying—The limiting of the compensation of county surveyors, under the present laws, has resulted in keeping competent men from accepting this office. This society therefore will petition the legislature to abolish such parts of the statutes as refer to this compensation and to prices to be paid for surveys, allowing the work to be paid for on its merits. 4. Free Engineering Services—It appears that several manufacturers of materials are offering the free services of their engineering forces to furnish detail plans of reinforced-concrete steel structures, tile-drainage systems and other engineering works. The society protests against this practice, as it is sometimes misleading to the public, is not conducive to fair and impartial commercial consideration and is demoralizing to the engineering profession.

More Mine Cave-Ins Threaten Parts of Scranton

Recent serious subsidences from mine caves in the City of Scranton, Penn., along North Main Ave. and vicinity, again make pressing some solution of a perplexing problem—the protection of surface and surface improvements when the anthracite coal that underlies the city is removed. The accompanying views, taken July 22, look like distorted photographs, but they do not by any means adequately show the actual conditions of things—a street with a surface like a roller coaster and buildings leaning against each other like inebriated companions.

This particular subsidence is alleged to have been caused by the mining operations of the People's Coal Co. and happened a few weeks ago, but numerous similar subsidences have occurred in the past in other parts of the city. The most valuable surface structure thus far injured is the 13th Regiment armory at Adams Ave. and Myrtle St., within a few minutes' walk of the business center of the city. A corner of the armory is shown in the lower right-hand view. This building cost over a quarter of a million dollars.

The City of Scranton is in the heart of the Pennsylvania anthracite field. Its beginning as a town dates from an iron manufactory, which assumed quite large proportions before anthracite mining became important. It was not until the '60's that anthracite mining was conducted on an extensive scale. The existence of the anthracite was of course known for many years before it came into extensive demand, and therefore the greater part of the land on which the City of Scranton now stands was acquired long ago by farsighted individuals because of its mineral wealth. The general practice has been for these owners and their heirs to lease the mining privilege to companies that carry on the mining operations and pay the owner a royalty.

As the city grew, the surface as well as the coal underneath became valuable. In a large part of the downtown business section the land was sold outright, with the coal under it, but there are large sections where the original owner in selling surface rights expressly reserved all mineral rights. In some instances, of course, the original owners were the coal operators themselves.

At the time most of these sales and leases were made it was the current practice of the mine operators to leave one-third of the coal in place as pillars to support the roof and prevent surface subsidence. Some few of the old leases specify this condition and guarantee the surface owner from damage caused by subsidences; other deeds and leases distinctly disclaim liability for any surface damage whatsoever.

Probably most of those who bought city lots did so on the supposition that past methods of mining would be continued and that the danger of subsidence (based on past experience) was negligible. At all events they went ahead and made surface improvements, in many instances of more value than the coal under them.

Today, increasing evidence points to the conclusion that not all coal operators, past or present, have been conscientious about leaving one-third of the richer and more easily worked coal seams—in other words, they have been guilty of "robbing the pillars." Subsidences over large areas of from 1 or 2 ft. to 8 or 10 ft. have occurred without warning. Sometimes such large areas have been involved as not to damage seriously ordinary frame dwellings on land that subsided. In most cases, however, the damage has been alarming and extensive.

The surface cover of the upper coal veins varies from nothing where the coal outcrops to 150 ft. or more. The immediate danger from subsidence is generally more serious where the cover is shallow, as under North Main Ave., in the views shown, where the mine workings are only 70 ft. below the surface. An examination of underground conditions, however, shows that the subsidence of large areas over old workings is imminent; in fact, is slowly but surely taking place.

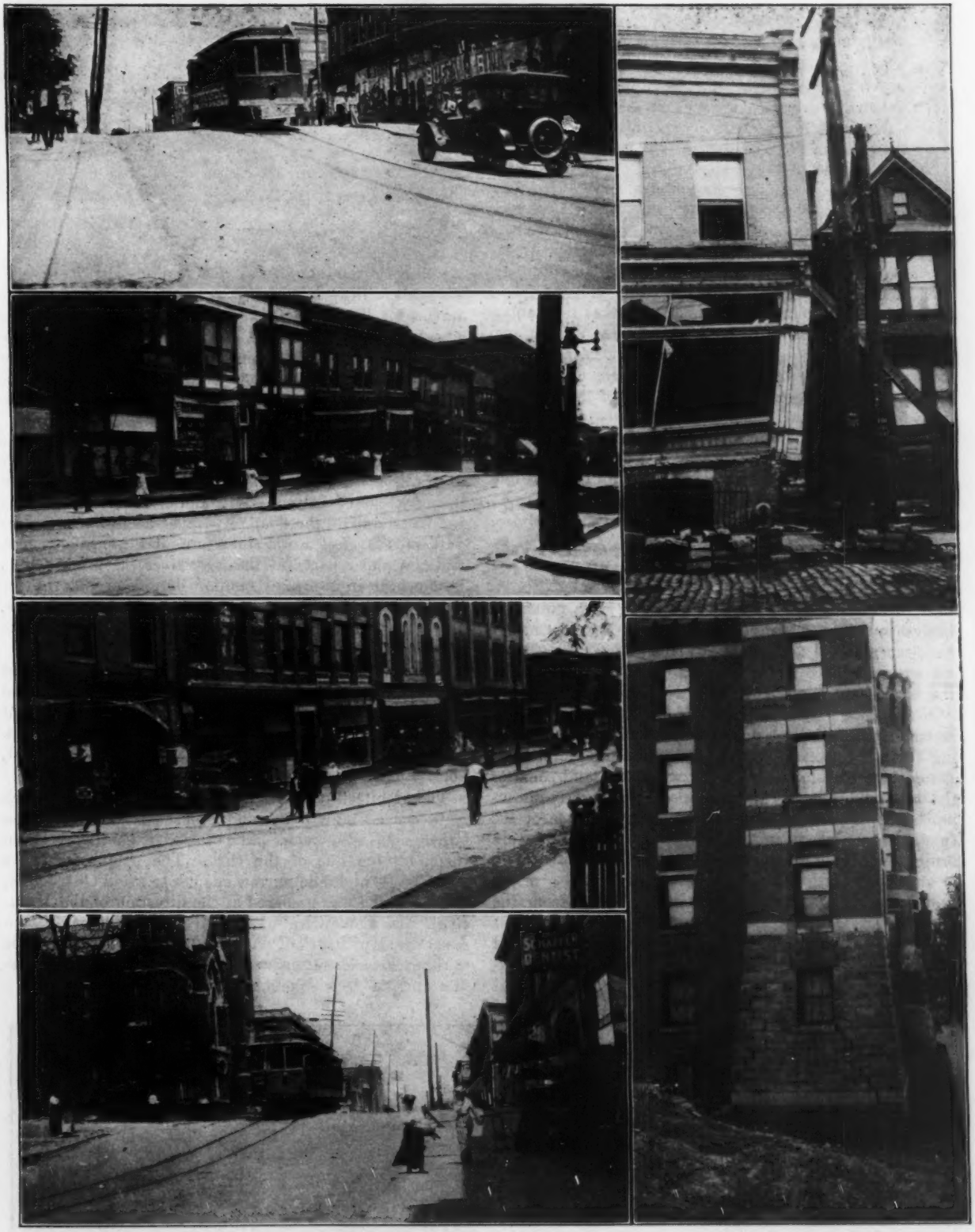
The number of veins under the city which have been worked varies from five to seven. Until recent years this mining was carried on without governmental supervision, with inadequate surveying methods and with no system whereby the pillars in the different veins or levels were columnized—that is, placed vertically over one another. The present condition of many acres of these old workings is impossible of determination, for large areas have been closed by squeezes, and other large areas have been purposely walled off by the mine operators.

The danger of extensive subsidences has long been recognized and has been the subject of more or less elaborate engineering investigations. An abstract of the report of the first of these will be found in *Engineering News*, Sept. 21, 1911, which describes in detail the mining methods that have been in vogue and the methods that were then recommended for preventing further subsidences. Such protection is essentially a simple matter; it means only the replacing of the coal with columns of masonry or else filling the old workings with culm or dirt.

It must be remembered, however, that about 250,000,000 cu.yd. of coal and refuse has been taken from under the city (about as much as the total excavation for the Panama Canal), and to replace all of this vast volume would be impossible, as well as unnecessary. Very little systematic filling, however, has been done, because no agreement can be reached as to who shall pay for it.

The courts have refused to hold the coal operators liable except in specific instances where they assumed liability through the original leases or deeds. Except in a few cases, like the armory above mentioned and two or three public-school buildings, a great part of the damage has been done to small dwelling houses and places of business, the owners of which have neither the means nor the heart to fight long drawn-out legal contests. Matters have now reached a crisis, however, and an organization known as the Scranton Surface Protective Association has been formed with several thousand members, which intends to fight out collectively the points of law involved.

Aside from the buildings mentioned there has been extensive damage to public property, as well as to private property. The illustrations give some idea of the present contour of the street surface, and any engineer can imagine what happens to subsurface structures—sewers, water and gas mains, etc.—under such conditions. The gas and water mains are owned by private interests, and it is



VIEWS OF SCRANTON, PENN., MINE-CAVE DAMAGE

The left-hand column shows views of North Main Ave. after a recent mine-cave, or general subsidence. The humps in the street mark places where the property owner attempted to protect his property by buying the coal under it, or where pillars of coal were left. The lower right-hand view is a corner of the 13th Regiment Armory

alleged that damages to these properties are paid for by the coal operators, but the city has collected damages for broken sewers only in rare instances. The courts have held in each instance that the city must show by deed or lease that it has absolute control of the coal under the streets. A case is now before the Supreme Court of the state involving damage done to North Main Ave., which was a public thoroughfare in the eighteenth century, or long before anthracite coal came into use.

In spite of the roller-coaster surface of the street the vitrified-pipe sewer has been kept in service, but because of the sags and low places, flushing out is frequently required. In some instances, however, it has been necessary to take up and relay sections of sewers on new grades. Fortunately, Scranton is a side-hill city, and drainage problems have so far been successfully solved.

From the foregoing it will be evident that the damage which has occurred is not a circumstance to what may occur. No one can predict what may happen. There are known to be large areas where one-third of the coal was not left for pillars—where less than half of that was left. It is known that anthracite disintegrates on contact with the atmosphere and that the pillars of coal which were left are gradually crumbling away. Subsidences may be gradual and uniform, but they seem certain to continue, unless extensive areas are underpinned or refilled.

Improving the Appearance of Chicago River Bridges

Improvement of the appearance of the numerous bridges over the Chicago River in the City of Chicago has been agitated for some years and is now being studied with reference to the new bridges to be built under the $5,000,000 bond issue recently authorized.

Most of the Chicago River bridges are of the through or half-through truss type, with two or three trusses rising above the floor level. The swing bridges are obsolete (those now remaining are to be removed), and some of the bascule bridges, while doubtless structurally unimpeachable, are not of attractive appearance. One of the fundamental ideas in improving the appearance of future bridges is to keep all the structural work below the deck, or at least beneath the parapet level. This will give the bridge an appearance of width and lightness from the approaches.

Not much can be done in the way of architectural treatment of the approaches, for the streets are of moderate width and are generally flanked by commercial buildings extending to the river bank. Hence, there is no opportunity for creating wide open spaces at the approaches. The most that can be done is to adopt some pleasing treatment for the masonry abutments and parapets, the operating cabins, electric-light posts and similar accessories, and place some decorative features on the approaches at the curb lines to form a distinctive entrance to the structure.

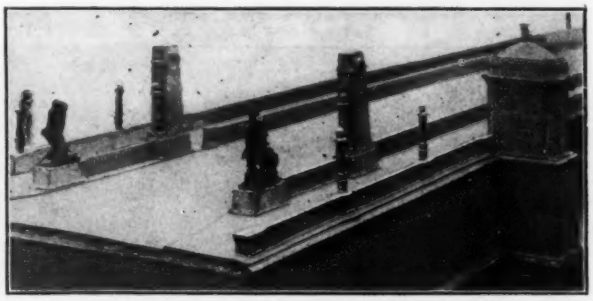


FIG. 2. PROPOSED ENTRANCE TREATMENT OF APPROACHES TO THE MADISON ST. BRIDGE AT CHICAGO

In the accompanying views is shown a model of a proposed ornamental treatment of the new bascule bridge at Madison St. The limitations of headway prevent the use of a curved bottom chord and necessitate extending the trusses above the floor to parapet height. The lower part of the steel work, therefore, has a girder effect, and the upper part (at the curb lines) is masked with ornamental ironwork of similar design to that of the outside parapets or hand rails. Fig. 1 is a general view, and Fig. 2 shows in more detail the treatment at the approaches.

The abutments are designed to be of granite, and the Pennsylvania R.R. has agreed that, if this is decided upon by the city, it will use granite for the river-front wall built in connection with the new Union Station. The operating cabins are to be of vitrified tile, with mat, glaze finish, imitating granite.

The architectural entrance treatment at each approach is to consist of a pylon and bronze statuary group on either side, with a low parapet wall extending between them, on the line of the curb. The pylons would be about 26 ft. high and narrow enough to avoid obstruction.

This model was prepared at the direction of the Municipal Art Committee of the Illinois Chapter of the American Institute of Architects. The committee is working in coöperation with the Chicago Plan Commission and the Department of Public Works.

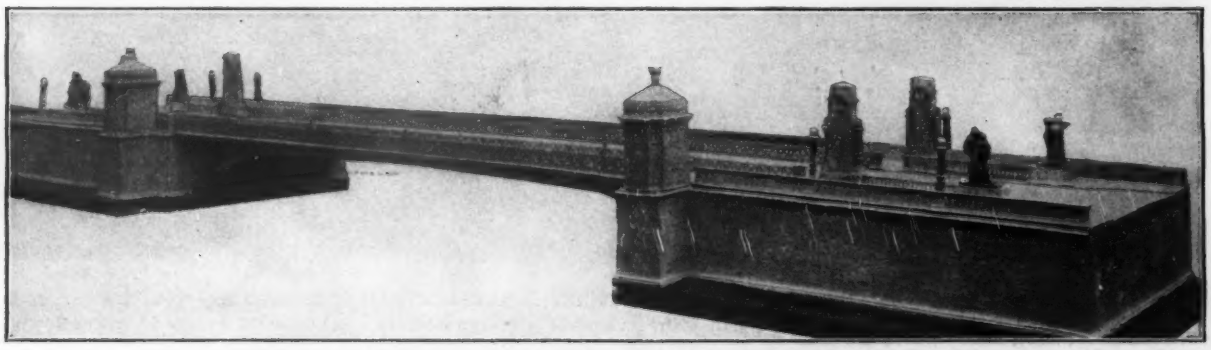


FIG. 1. MODEL OF PROPOSED DESIGN FOR MADISON ST. BRIDGE AND APPROACHES AT CHICAGO

FIG. 3. BASCULE BRIDGE OVER THE CHICAGO RIVER AT JACKSON ST.

The excellent appearance of a deck bridge as part of a public street, as compared with a bridge having the roadway broken by projecting trusses, is shown strikingly by the new Jackson St. bascule bridge, built by the Strauss Bascule Bridge Co. and opened a few months ago. A view of it is given in Fig. 3. A slightly greater headway here permitted the use of curved bottom chords, and it enabled all structural work to be kept below the deck, so that there are no parapets between the sidewalks and roadway, as in the Madison St. design. This gives a fine open appearance to the bridge.

The abutments at Jackson St. are of reinforced concrete, housing the operating machinery, and upon each is an operator's tower, with concrete lower portion surmounted by a cabin of steel, copper and glass. A simple decorative treatment is given to the concrete work, and the tower is paneled with inserted lines of tile. The design of the abutments and operating towers at this bridge was the result of coöperation between the engineers and the Chicago Plan Commission.

Torsional Endurance and Impact Machines

A machine for endurance experiments using alternating torsion in a peculiar way has been built at the Naval Engineering Experiment Station at Annapolis. It was described by D. J. McAdam, Jr., in a paper "Endurance and Impact Tests of Metals." Arm *b* (see Fig. 1) grips one end of the specimen (Fig. 2), which is journaled in two bearings in the frame. The other end is held by arm *e*, whose outer extremity engages the opposed springs *f* and registers on the drum *h*. The throw of the crank disk *a* can be varied. With a given throw, the torsional load on the specimen is less when the specimen yields than

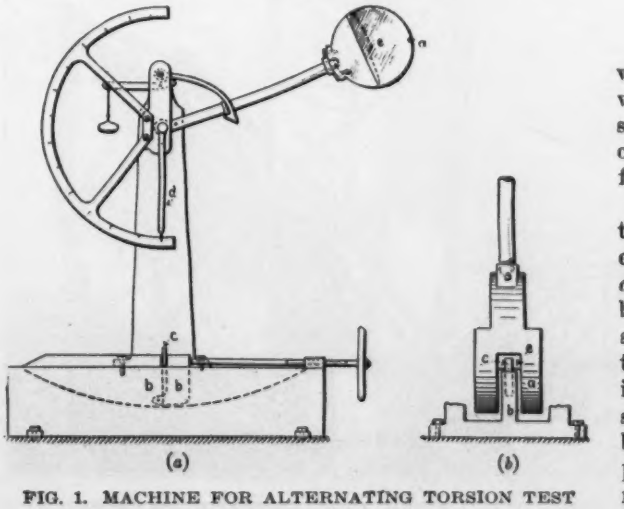


FIG. 1. MACHINE FOR ALTERNATING TORSION TEST

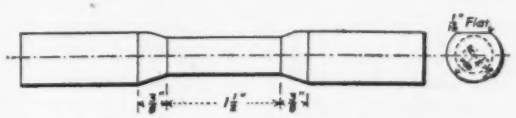


FIG. 2. SPECIMEN FOR ALTERNATING TORSION TEST

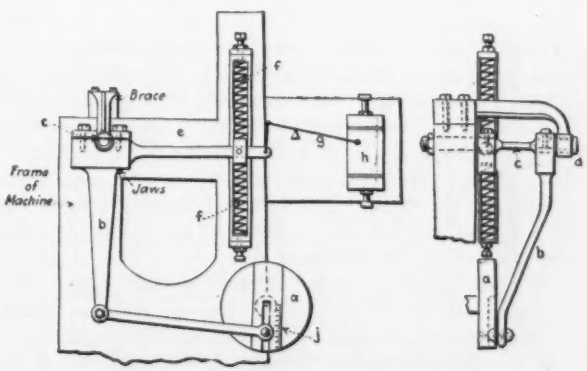


FIG. 3. IMPACT-SHEAR TEST MACHINE

when its deformation is small. Tests have been run with various steels at loads producing rupture at several thousand cycles. Such tests have been applied to the problem of choosing between half a dozen different heat-treatments for chrome-nickel steel.

An impact-shear testing machine was also built, and tests are being run on it for comparison with the torsion-endurance tests. This is shown in Fig. 3. The specimen *c*, 3/8 in. wide and 1/4 in. thick in the direction of the blow, is held by the vise *bb*, and its projecting end is sheared off by the punch *e* in the pendulum *a*. After the break, the pendulum carries the dead pointer *d* with it, and thus the residual energy is measured, giving by subtraction the foot-pounds absorbed by the break. After breaking a piece, it can be moved up in the vise and repeated breaks made. The average rupture work for tough metal is about 45 to 50 ft.-lb.

News of the Engineering World

Bascule Bridge Replaces Old Swing Bridge

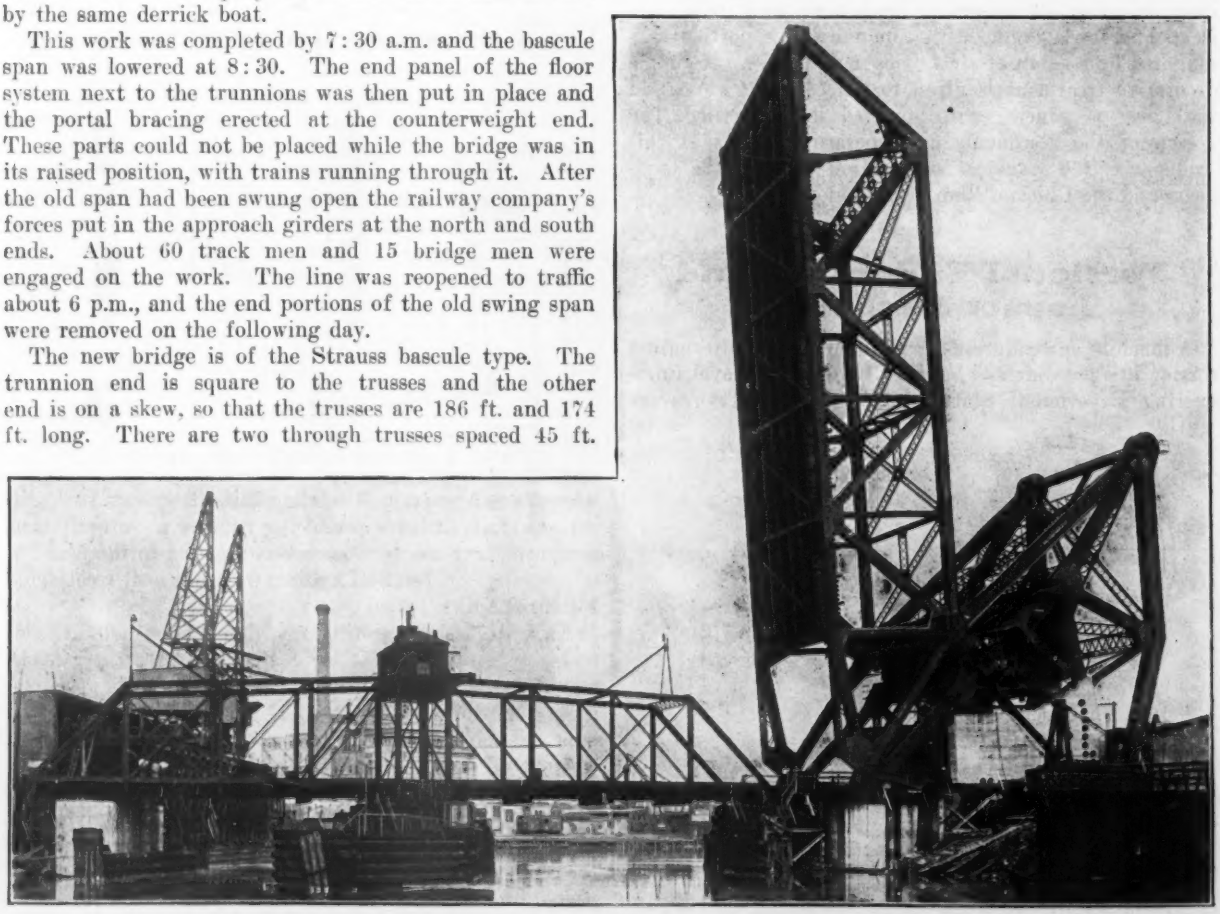
The new 186-ft. three-track single-leaf bascule bridge of the Chicago & Northwestern Ry. over the Chicago River near Fullerton Ave., Chicago, was put in service July 30 (Sunday). It takes the place of an old double-track center-pier swing bridge. The new structure was erected in the open or raised position, the end floor panel being left incomplete to allow trains to pass through while the work was in progress. The accompanying view affords an interesting comparison of the old and new structures.

Traffic was suspended soon after midnight, and work was commenced at 12:30 a.m. The old bridge was swung into the open position and blocked up on the protection pier, and the operating machinery was removed by a derrick boat. The middle portion, for a width sufficient to enable the bascule span to be lowered, was then cut away by means of oxyacetylene torches and the parts were loaded upon a scow by the derrick boat. These parts were afterward cut up by the torches and loaded on cars by the same derrick boat.

This work was completed by 7:30 a.m. and the bascule span was lowered at 8:30. The end panel of the floor system next to the trunnions was then put in place and the portal bracing erected at the counterweight end. These parts could not be placed while the bridge was in its raised position, with trains running through it. After the old span had been swung open the railway company's forces put in the approach girders at the north and south ends. About 60 track men and 15 bridge men were engaged on the work. The line was reopened to traffic about 6 p.m., and the end portions of the old swing span were removed on the following day.

The new bridge is of the Strauss bascule type. The trunnion end is square to the trusses and the other end is on a skew, so that the trusses are 186 ft. and 174 ft. long. There are two through trusses spaced 45 ft. c. to c. for the three tracks. The clear width of channel is 145 ft. (on the square), and the headway above the water is 18 ft. 3 in. The total weight of structural steel (including trunnions, pins, sleeves, bearings, stairs, platforms, anchorage and grillage) is 1,250 tons; the operating and lock machinery weighs 92,840 lb. The concrete counterweights are a new design, placed only at the sides (instead of extending across the tracks), so that they could be erected without blocking traffic. They contain 522 cu.yd. of concrete (4,536 lb. per yd.) and 12,300 lb. of reinforcing bars. Holes are left in the concrete for adding pig iron or bars to adjust the weight. The bridge is operated by two 150-hp. electric motors which can open or close it in one minute. An auxiliary 50-hp. gasoline engine is provided in case of failure of current or accident to the electrical machinery.

The bridge was designed by the Strauss Bascule Bridge Co., of Chicago. The substructure was built by the Great Lakes Dredge and Dock Co., of Chicago, which also cut apart the old span. The steel for the superstructure was furnished by the American Bridge Co. and was erected



NEW BASCULE BRIDGE AND OLD SWING BRIDGE OVER THE CHICAGO RIVER; CHICAGO & NORTHWESTERN RY.

by the Kelly-Atkinson Construction Co., of Chicago. The design and construction of the bridge, and the work of changing from the old to the new structure, were all under the direction of W. H. Finley, Chief Engineer, Chicago & Northwestern Ry.

Report on Boston Edison Tunnel Accident

The fatal accident of June 24, 1916, in the shaft and tunnel under construction for the Edison Electric Illuminating Co., at Summer St., Boston, by the Hugh Nawn Contracting Co., has just been reported on by Edwin Mulready, State Commissioner of Labor. The report suggests that the shaft shell tore apart and "blew up," presumably because the shaft was not strong enough for the tension due to the high air pressure. The report says:

About 7:47 a.m. on June 24, 1916, the vertical airlock and shaft blew up. The four men who were working in the tunnel itself were killed, and three men who were in the airlock were uninjured.

This work is being done under about 31 lb. pressure. The shaft is about 80 ft. in depth, with a 10-ft. heading at the bottom. The tunnel itself is about 7 ft. in diameter. The airlock is also about 7 ft. in diameter and held about eight men at the time of the accident.

The probable explanation of the accident as learned from investigation is that the air chamber at the point where heading started snapped off and blew up. At the broken point in the shaft sand and water rushed in. The manhole arrangement of the vertical shaft is now only 3 ft. above ground, but after the accident it was pushed up about 5½ ft. upon the ground and canted at an angle of about 45°. This shaft is situated at the bridge at Summer St. at the beginning of L St. There were three colored men and one white man killed.

Standard Warnings for Grade-Crossing Protection

Committees of the National Association of Railway Commissioners and the American Railway Association have coöperated in planning standard warning signals for grade crossings of railways and highways. The principal feature of the new standard is the placing of a cautionary sign beside the highway at least 300 ft. back from the railway track. This warning sign is to be a circular disk 24 in. in diameter, painted white with a black border and a black cross, with the letters R.R. above the horizontal arm of the cross. This disk is to be placed beside the road on top of a pole of sufficient height to be seen at some distance; and on much traveled roads it is recommended that these warning signs be lighted at night. The additional signs now in use or required by law, which are placed directly at the crossing, are to be continued.

In place of the white flag now generally used by guards at crossings to warn back approaching traffic, which has sometimes been misinterpreted by drivers of vehicles as meaning safety, the committee recommends that crossing guards shall display a white disk 16 in. in diameter with a black border, with the word "Stop" painted across the center in 5-in. black letters.

A further recommendation of the committee is that crossing gates should be painted white with alternate diagonal stripes of black. Experiments have shown that gates so painted are more striking to the eye than when painted one solid color. The railways are also required to grade the highway approachings at crossings so that there will not be a sharp grade close to the crossing, to reduce the liability of teams or motors being stalled just as they reach the crossing.

The action of these committees is to be reported to the National Association of Railway Commissioners at its meeting in Washington next November, and if approved a movement will be started, with the coöperation of the American Automobile Association, to secure uniform legislation in the various states to cover the protective measures above outlined.

The Pennsylvania R.R. Changes Signal-Color Scheme

A complete change in the color scheme of signal indications will be made on the entire Pennsylvania R.R. system just as soon as the necessary materials can be obtained, orders already having been placed. White lights are to be eliminated altogether as a signal, being replaced by green, indicating "clear" or "proceed." This step is taken on account of the increasing use of white lights of various kinds in buildings, driveways, roads and streets close to or adjacent to the right-of-way.

The railroad states that it was unwilling to proceed with this change until a yellow glass could be obtained for the caution signals, which would give a bright light at long distances and still would not be liable to be mistaken for white. Not only will alterations have to be made in all semaphores, but the following devices also will be effected: Marker lights on the rear of passenger and freight trains, switch lamps and targets, markers for track tanks, "slow" signs, "resume-speed" signs, hand lamps, and the light displayed to the public at crossing gates. Lights for the last-named purpose will be red instead of green.

A Falling Boom cut through the roofs of three houses in Los Angeles, Calif., on the afternoon of July 31. A large steel derrick was used to erect an elevated-railway structure being constructed to San Pedro St.; a cable slipped and the boom fell, cutting through the roofs of three houses to the first floors. There were no casualties.

A Broken Reclamation Dike near San Francisco caused floods which stopped all traffic between Oakland and Alameda, over Webster St., on July 25. The first floor of the Panama Hotel was covered with mud, while the plant of the Bay Wrecking Co. and several industrial plants were threatened. The dikes are part of a plan to reclaim the Alameda marshes and convert them into industrial sites. Fill is made by suction dredges pumping against the 10-ft. dikes built along Webster St.

Hypochlorite Treatment of Oysters from Polluted Waters appears to be safe and practicable, according to William F. Wells, sanitary chemist, United States Public Health Service ("Public Health Reports," July 14, 1916, pp. 1848-52). Acting on the knowledge obtained by Prof. E. B. Phelps and others that oysters from polluted layings are rapidly freed from B. coli on being placed in clean water, tests were made with oysters placed in galvanized wire baskets and suspended in water treated with calcium hypochlorite. From 0.25 to 0.63 p.p.m. of available chlorine were used, the periods of immersion ranging from 4 to 29 hr., with a second period of 12 to 24 hr. in some cases. The conclusion reached in the report is that:

The experiments are believed to prove that oysters which have laid in polluted water can be artificially purified to such a degree as to pass a most rigid standard by exposure for a short period in water containing calcium hypochlorite, and they appear also to demonstrate the feasibility of such a process.

An Excursion Boat Equipped with Diesel Engines began running on the Hudson River at New York City on July 17. The boat can accommodate 300 passengers and is driven by a pair of four-cylinder Diesel marine engines of 240 hp. each, giving it a speed of about 12 knots. The engines were built by the Southwark Foundry and Machine Co., of Philadelphia, under the Harris patents. They have stepped pistons and in starting the engine the compressed air acts upon the annular piston and does not enter the cylinder in which combustion takes place. Thus is avoided the sudden changes of tem-

perature which occur in other Diesel engines when compressed air expanded to a temperature of far below zero is admitted into a cylinder which has an instant before had combustion going on within it at a temperature of several thousand degrees. In normal working, the annular piston compresses the scavenging air and is of sufficient area so that the volume of the scavenging air is about 75% in excess of the volume of the main working cylinder, thus insuring thorough scavenging. The boat has been built for George W. Perkins, President of the Palisades Interstate Park Commission, to carry excursionists from a pier at 129th St. to the piers which have been built along the waterfront at various points under the Palisades for the benefit of campers, canoeists and picnic parties.

A Subway for Sydney, N. S. W., has just been commenced, according to a statement in "The Indian and Eastern Engineer." Work is to be prosecuted from four or five places and will take about five years to complete.

On the Australian Transcontinental Ry., according to the "Commonwealth Engineer" for June, track laying has progressed 770 mi., leaving 283 mi. still to be laid. The estimated total expenditure on the line to June 30, 1916, is $25,000,000.

Mill Creek Flood Channel at Erie Started—On the anniversary of last year's destructive flood at Erie, Penn., work on improvement of Mill Creek channel was formally inaugurated Aug. 3. The creek is to be converted into a concrete-lined conduit.

The Pikes Peak Motor Highway, described in "Engineering News," Dec. 23, 1916, was opened Sunday, July 23. The road is from 20 to 50 ft. wide, the maximum grade is 10½%. The elevation of the summit is 14,109 ft. above sea level, which is claimed to be the highest altitude accessible to motor vehicles. The road is to be used for hill-climbing contests.

Ratings in the Examination for Senior Civil Engineer in the Valuation Department by the Interstate Commerce Commission, held Nov. 2, 1915, have been announced by the Civil Service Commission as follows: There were 438 competitors in the examination. The number of eligibles who obtained an average percentage between 90 and 100 was 55; between 80 and 90, 129; and between 70 and 80, 70.

Douglas County, Nebraska, Highway Paving will probably be held up until another season. The legality of the bond issue is now in question before the courts. The amount of the bonds voted was $1,700,000, but no more than $500,000 is to be spent in any one year. It was specifically provided in the law that all the new pavements were to be brick on a concrete base. The law was also unusual in specifying exactly what county roads were to be improved. There is much preliminary engineering work to be done, which cannot be undertaken until the legality of the bond issue is established.

Exportation of Natural Gas from Alberta has been prohibited by the Provincial Government, thereby blocking projects which had been mooted for piping supplies to points in Saskatchewan and Manitoba. The act ratifying an agreement between the City of Edmonton and the Northern Alberta Natural Gas Development Co., Ltd., was amended so as to prevent the company from piping gas beyond the boundaries of the province. It is the intention of the Government to embody a similar clause in any charters that may hereafter be granted empowering companies to supply natural gas.

Operations of the Portland Cement Industry for the first half of 1916 are reviewed in a bulletin of the Geological Survey. Two new cement plants have been opened in this period; one at New Duluth, Minn., and the other at Houston, Tex. The one at New Duluth belongs to the Universal Portland Cement Co. and uses as raw material slag from the blast furnaces of the Minnesota Steel Co. and limestone from Alpena, Mich. The plant at Houston is mill No. 2 of the Texas Portland Cement Co. and uses oyster shells dredged from a reef in Galveston Bay and clay from Harrisburg, Tex. The bulletin notes the rise in the price of cement and remarks that this does not represent wholly increased profits to manufacturers as there has been a large increase in the cost of explosives for blasting, of labor and of fuel.

Comparing Tension and Transverse Tests of Cast Iron—For a series of comparisons of the tension test and the transverse test of cast iron a device for use in the transverse test was designed to H. L. Morse, of Watertown Arsenal, who also described it in a paper before the American Society for Testing Materials entitled, "An Apparatus for Testing the Standard Cast-Iron Arbitration Bar." The device was designed for use in a horizontal Emery machine; the support or anvil is screwed to the weighing piston, while a loading block containing a pin which applies the load is screwed to the loading piston. Pins in the anvil furnish a seat for the test bar. A little plunger under the middle of the bar receives the deflecting movement and transmits it by way of a bell crank to the push rod of an Ames dial. This dial rod moves outward for deflection of the bar and is not subject to injury when the bar breaks.

A Large Deep-Water Dock has been under construction in London since August, 1912. This undertaking includes the creation of an inclosed deep-water area accessible to large ships. The site is for the most part low-lying land, but a total of some 3,500,000 cu.yd. of material had to be removed to secure the desired depth of 38 ft. below the level of the impounded water. Excavation is practically completed. The dock tapers in width from 700 ft. to 500 ft., and will have a quayage of 10,000 lin.ft. Seven jetties run parallel with the south quay. It will be possible for barges to lie between the jetties and the quay, so that steamers can deliver cargoes into craft on either side of them as well as on to the quay by crane. The entrance lock from the Thames is 800x100 ft. in plan and has a depth below high-water mark of 45 ft. There are three sets of steel gates, dividing the lock into compartments. The lock can be extended 100 ft., by placing a caisson at the inner end. The walls of the lock have been constructed and the bottom is being put in. The new dock will be connected with the Albert and Victoria docks by means of a passage 100 ft. in width, the walls of which are now under construction. A large dry dock is an important part of the enterprise, and is to be 750 ft. long by 100 ft. wide, which width is claimed to be greater by 20 ft. than that of any other drydock available in the port of London.

PERSONALS

F. X. Bode has been appointed Deputy City Engineer of Troy, N. Y., to succeed J. C. Watts, resigned, as noted elsewhere.

G. B. Arthur has been appointed District Engineer of the Portland Cement Association, with headquarters at Parkersburg, W. Va.

J. C. Watts, Deputy City Engineer, of Troy, N. Y., has resigned to become Engineer of the Harbor and Dock Commission of the same city.

B. E. Merrell, Civil and Mining Engineer of St. Petersburg, Fla., has been made Superintendent and Engineer of a large dredging project at Boca Grande, Fla.

J. Harold Rapp, formerly Vice-President and General Manager of the W. N. Kratzer Co., Pittsburgh, Penn., has resigned to open an office in the Fulton Bldg., Pittsburgh, as a consulting structural engineer.

George W. Nichols, recently Engineer with John Eichleay, Jr., Co., Pittsburgh, Penn., is now in charge of structural steel designing and construction for the S. C. Webb Engineering Co., also of Pittsburgh.

Ambrose Swasey, President of the Warner & Swasey Co., Cleveland, Ohio, has been made an honorary member of the American Society of Mechanical Engineers. He was a founder member of the society in 1880.

D. Y. Swaty, Assoc. M. Am. Soc. C. E., formerly Construction Engineer of the Great Lakes Dredge and Dock Co., Cleveland, Ohio, has been made Vice-President of the Cleveland Engineering Construction Co.

P. B. Waldin, formerly Assistant Engineer of the Florida East Coast Ry., has been appointed Sales Manager for the Virginia territory of the Monroe Calculating Machine Co., with headquarters at Richmond.

John C. Johnson, Assoc. Am. Inst. E. E., formerly Engineer of Electrical Construction of the Cleveland Municipal Electric Light Plant, is now a member of the F. W. Ballard Co., Swetland Bldg., Cleveland, Ohio.

L. G. Wallis, recently Resident Engineer of the Southern Ry. at Spartanburg, S. C., has been appointed Engineer of Construction of the Jacksonville Terminal Co., Jacksonville, Fla., and will have charge of the erection of the new union station.

H. H. Dare, M. Inst. C. E., of Roseville, New South Wales, Australia, has been appointed a member of the Water Conservation and Irrigation Commission of New South Wales. Other members of the commission are W. C. Grahame, Minister of Agriculture, and W. Neville Sendall.

John V. W. Reynders, M. Am. Soc. C. E., recently Vice-President of the Pennsylvania Steel Co., in charge of the Steelton plant, has opened offices in the Equitable Bldg., New York City, as a consulting engineer. He is a graduate of Rensselaer Polytechnic Institute and has made structural engineering his life work.

Ralph G. Kirk has resigned as Superintendent of Construction at the Steelton plant of the Bethlehem Steel Co.

Charles J. Gadd, former Engineer in charge of construction of the American Iron and Steel Manufacturing Co., Lebanon, Penn., has been promoted to be Chief Engineer.

Robert W. Hunt, M. Am. Soc. C. E., of Chicago, Ill., was awarded the honorary degree of Doctor of Engineering at the recent commencement at Rensselaer Polytechnic Institute.

F. O. Hale, Chief Engineer of the Southwestern Bell Telephone System, has been promoted to be General Manager of the Southwestern Telephone and Telegraph Co., with headquarters at St. Louis, Mo.

W. O. Pennell, Assoc. Am. Inst. E. E., of the engineering department of the Southwestern Bell Telephone System, has been promoted to be Acting Chief Engineer, to succeed F. O. Hale, promoted, as noted elsewhere.

W. S. Dale, for three years Chief Engineer and General Superintendent of the Santa Monica Water Co., Santa Monica, Calif., has been appointed Superintendent of the municipal water-works, which has purchased the Santa Monica Water Co.

OBITUARY

Robert McCallum, former City Architect, of Toronto, Ont., died Aug. 2. He was 65 years old. He was at one time a civil engineer with the Ontario Provincial Government.

William B. Upton, a civil engineer of San Francisco, Calif., died July 30. He was a native of San Francisco, and was 59 years of age. He had charge of construction of the Argentine Building at the Panama-Pacific Exposition.

Robert Safford Towne, M. Am. Inst. M. E., President of the Metalurgia Mexicana, a mining engineer of long experience in Mexico, died Aug. 3, at his apartment in the Engineers Club, New York City. He was born in Portsmouth, Ohio, 58 years ago. He graduated from Ohio State University in 1879. He was an officer in many Mexican corporations, including the Mexican Northern Ry., of which he was President and Treasurer, the Alvarez Land and Timber Co., the Mexican Lead Co. and others.

A. M. Valz, a prominent contractor of Staunton, Va., died July 22, at the Union Protestant Infirmary at Baltimore, Md. He was born in Italy in 1848, and was graduated at the University of Turin as a civil engineer. He came to America in 1866. In attempting to return to his native country in 1871 he narrowly missed being executed at Paris during the French revolutionary troubles. Escaping to this country he began work as a contractor on the construction of a stone bridge on the Valley R.R. Subsequently he became one of the most important contractors in that part of the South. He is survived by a widow, four sons and two daughters. One son, Arthur M. Valz, has been associated with his father under the firm name of A. M. Valz & Son.

Arthur Hider, M. Am. Soc. C. E., Principal Assistant Engineer, Mississippi River Commission, Third District, died at Greenville, Miss., July 28, 1916. He had been connected with the Mississippi River improvement work since 1879, giving the best years of his life to the development and perfection of plans for the control and improvement of the river, and a large share of credit for successful work is due to his faithful, untiring, and patient attention to the duties of his position. For the past 25 years of his life he was the Assistant in charge of all the bank revetment work in the Third Mississippi River District, and also in charge of the design and construction of towboats, tugs, hydraulic graders, and all the various items of plant that are required for the work of river improvement. He was unquestionably an authority on Mississippi River work. In addition to his work with the Mississippi River Commission, Mr. Hider while on vacations and during spare time served as Consulting Engineer, passing on the plans for many large undertakings, some of which are as follows: Design and installation of water-works systems at Greenville and Hollandale, Miss., Lake Providence, La., and other places; he was expert member of Valuation Committeee to determine value of the Memphis, Tenn., water-works system when this was taken over by the City of Memphis. Before his connection with the Mississippi River Commission, he was in the City Engineer's department at Louisville, Ky., and was in charge of considerable municipal engineering work. He had been a member of the American Society of Civil Engineers since 1881, and contributed many papers and discussions to the "Proceedings." Mr. Hider is survived by a wife, three sons and two daughters.

ENGINEERING SOCIETIES

INTERNATIONAL ASSOCIATION OF FIRE ENGINEERS.
Aug. 29-Sept. 1. Convention in Providence, R. I. Secy., James McFall, Roanoke, Va.

ASSOCIATION OF EDISON ILLUMINATING COMPANIES.
Sept. 4-7. Convention in Hot Springs, Va. Asst. Secy., E. A. Baily, 360 Pearl St., Brooklyn, N. Y.

THE TRAVELING ENGINEERS' ASSOCIATION.
Sept. 5-8. Annual meeting in Chicago, Ill. Secy., W. O. Thompson, care General Offices, N. Y. C. R.R., Cleveland, Ohio.

AMERICAN FOUNDRYMEN'S ASSOCIATION.
Week of Sept. 11. Annual meeting in Cleveland, Ohio. Secy., A. O. Backert, 12th and Chestnut St., Cleveland, Ohio.

THE AMERICAN INSTITUTE OF METALS.
Week of Sept. 11. Meeting in Cleveland, Ohio. Secy., W. M. Corse, 106 Morris Ave., Buffalo, N. Y.

NATIONAL ASSOCIATION OF STATIONARY ENGINEERS.
Sept. 11-16. Convention, Minneapolis, Minn. Secy., Fred W. Raven, 417 S. Dearborn St., Chicago.

MASTER CAR AND LOCOMOTIVE PAINTERS' ASSOCIATION.
Sept. 12. Convention in Atlantic City. Secy., A. P. Dane, Reading, Mass.

RAILWAY SIGNAL ASSOCIATION.
Sept. 12-14. Convention in Mackinac Island. Secy., C. C. Rosenburg, Myers Building, Bethlehem, Penn.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Sept. 13-15. Convention in Portland, Me. Secy., Willard Kent, Narragansett Pier, R. I.

ILLUMINATING ENGINEERING SOCIETY.
Sept. 18-20. Convention in Philadelphia, Penn. Asst. Secy., C. D. Fawcett, 29 West 39th St., New York, N. Y.

ASSOCIATION OF IRON AND STEEL ELECTRICAL ENGINEERS.
Sept. 18-22. Convention in Chicago. Secy., W. O. Oschmann, Oliver Iron and Steel Co., Pittsburgh, Penn.

ROADMASTERS AND MAINTENANCE OF WAY ASSOCIATION OF AMERICA.
Sept. 19-22. Convention in New York City. Secy., P. J. McAndrews.

MICHIGAN GAS ASSOCIATION.
Sept. 21-22. Annual meeting in Detroit, Mich. Secy., Clark R. Graves, Lansing, Mich.

AMERICAN PEAT SOCIETY.
Sept. 21-23. Annual meeting in Washington, D. C. Secy., Julius Bordollo, Kingsbridge, N. Y.

RAILWAY FIRE PROTECTION ASSOCIATION.
Oct. 3-5. Convention in New York City. Secy., C. B. Edwards, Mobile & Ohio R.R., Mobile, Ala.

AMERICAN SOCIETY OF MUNICIPAL IMPROVEMENTS.
Oct. 9-13. Convention in Newark, N. J. Secy., Charles C. Brown, Indianapolis, Ind.

AMERICAN ELECTRIC RAILWAY ASSOCIATION.
Oct. 9-13. Convention at Atlantic City, N. J. Secy., E. B. Burritt, 8 West 40th St., New York City.

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION.
Oct. 17-19. Convention in New Orleans. Secy., C. A. Lichty, C. & N. W. Ry., Chicago.

AMERICAN GAS INSTITUTE.
Oct. 17-20. Annual meeting in Chicago. Secy., G. G. Ramsdell, New York, N. Y.

AMERICAN PUBLIC HEALTH ASSOCIATION.
Oct. 24-27. Convention in Cincinnati, Ohio. Secy., Prof. Selskar M. Gunn, Boston, Mass.

The American Electric Railway Association and its affiliated associations, will hold an annual convention at Atlantic City, Oct. 9 to 13.

The National Smoke Prevention Association will hold its 11th annual meeting in St. Louis, Sept. 26, with headquarters at the Planters Hotel. Among the papers to be presented are the following: "Smoke of Heating Plants," "Feeding Boilers and Furnaces," "Chimney Drafts," "Powdered Coal as Fuel." The third day of the session will be "Railroad Day." The officers of the association are: President, Wm. H. Hoffman, vice-president, Charles W. Heath, secretary, Frank A. Chambers, of the Chicago Smoke Department. The Joint Smoke Prevention Committees of St. Louis, recently organized, will provide for the entertainment of the delegates. The Chairman of this joint committee, A. P. Greensfelder, is a past-president of the Engineers Club of St. Louis.

The American Institute of Mining Engineers for the first time will hold its annual meeting in Arizona, Sept. 18 to 25. A special train will leave New York City (Grand Central Terminal) at 5:30 p.m., Thursday, Sept. 14. At 4 p.m. Friday, the train will arrive at Chicago, and the party will be taken by automobile for a two hours' drive, returning to the La Salle Hotel for dinner. On Monday, Sept. 18, the party will reach Santa Rita, and from that point will visit the mines of the Chino Copper Co. and the mill of the Empire Zinc Co. The next day the reduction works of the Copper Queen Consolidated Mining Co. and of the Calumet and Arizona Mining Co. will be visited, while in the afternoon a technical session will be held on "Smelting," and another after dinner on "Leaching." On Sept. 21, the mine and reduction works of the

Old Dominion Copper Co. will be inspected and in the afternoon a session will be held on "Concentration and Flotation." On Sept. 22, the works of the International Smelting and Refining Co., and the mills of the Inspiration Consolidated Copper Co. will be visited. Returning, the special train will arrive at Grand Central Terminal, New York City, at 9:40 a.m., Thursday, Sept. 28. The total mileage of the trip will amount to 6,473.

Appliances and Materials

Anti-Corrosion Steel Fittings

Since the development by the Research Laboratory of the General Electric Co. of "calorized" metals—surface alloys of aluminum—which are resistant to destruction by high temperatures or by ordinary corrosion, license for use of this material in soot-blower fittings has been secured by the Diamond Power Specialty Co., of Detroit. This company has a device for cleaning the outside of water-tube boiler tubes; difficulty has been experienced from the short life of tips and pipes exposed to the furnace gases in the hotter passages. The trade name "Insuluminum" has been attached to these products.

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Flexible Sewer-Pipe Joint Compound

A new pipe-joint compound, called the "Superior," for sewer lines has been recently put out by the Superior Chemical Co., Chemical Building, St. Louis, Mo. It is melted and poured into place. It adheres to both tile and iron and after hardening it is claimed to remain pliable and tight.

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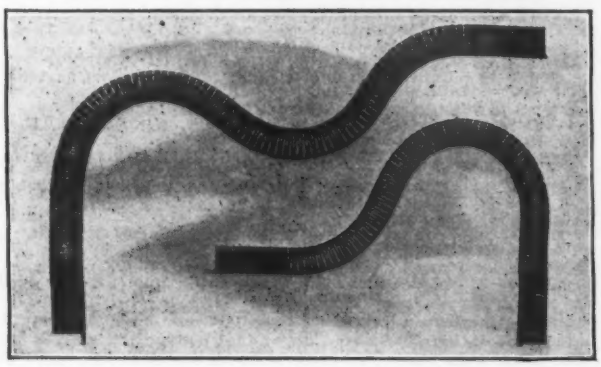
New Flexible Curve Rule

A new type of flexible curve rule for drafting offices has been devised by Keuffel and Esser Co., of Hoboken, N. J. The aim has been to secure the flexibility of older rules but with extreme lightness. The body is a strip of black xylonite with overlapping alternate notches from opposite edges. Along



NEW FLEXIBLE CURVE RULE

one edge is a ruling strip of the same material, and along the other edge is a metal wire holding the rule in any curve into which it is bent. Each extremity ends in a tangent.

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New Comparison Pyrometer

A new pocket pyrometer, bearing the trade name "Irite," is being made by the Gibb Instrument Co., Highland Building, Pittsburgh, for measuring the temperature of furnaces, heated pieces, ingots, soaking pits, etc. It is of the comparison type and has a color wedge, showing the different shades (calibrated) of color taken on by a heated body, and diffusely illuminated by a small incandescent lamp supplied with current from a dry cell in the pyrometer tube. The color wedge is shifted until a match is secured with that of the piece under study and the temperature is read off. The pyrometer sells for $25.

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Tool for Roughing Concrete Walks

A special tool has been devised by the Gardner Governor Co., of Quincy, Ill., for roughing slippery sidewalks. It is intended for use with an air-driven plug drill, and consists of a shank with a square case on the end carrying 16 hard steel points. The case also has a bail handle to help in guiding.

A complete sidewalk dressing plant consists of small air-cooled compressor driven by a gasoline engine, both mounted on a little steel hand truck.

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Motor-Driven Sewage Ejector

A new design of sewage receiver and ejector for office buildings has been made by the Yeomans Brothers Co., Institute Place, Chicago, Ill. There is a cast-iron tank to be placed in a concrete-lined dry pit, and to this are connected all sewers that will not drain into the street sewers. On either side of this and drawing from the bottom are two vertical-shaft centrifugal pumps. The top of the receiver supports a platform on which are mounted the two pump motors and the automatic-control switchboard. The pump casing can be opened up for cleaning without disturbing the shafts and bearings. The control float is in an 8-in. housing pipe. The ejector is regularly built in sizes ranging in capacity from 200 to 1,000 gal. per min.

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Oxygas Lead-Burning Outfit

An outfit for greater convenience in fusing together lead sheets, etc., has been developed by the Safety Car Heating and Lighting Co., of New York City, American maker of Pintsch gas and equipment. The oxyhydrogen flame has previously been generally used, but this has been expensive and sometimes hazardous. In railway battery houses, shops, etc., low-pressure (12 atmospheres) Pintsch gas is available from car tanks; for other places high-pressure (100 atmospheres) flasks are provided, to be carried about as needed and the torches supplied direct through reducing and regulating valves. An outfit comprises a high-pressure or low-pressure regulator, oxygen flask with regulator, 25 ft. of hose, mixing valve, torch and wrench. Burner tips are furnished with different-sized orifices for various work.

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"Unaflow" Engines for Rolling Mills

Two engines of the Stumpf "Unaflow" design (exhausting from ports in the center of the cylinder instead of at the ends) are being made by the Nordberg Manufacturing Co., of Milwaukee, Wis., for the Youngstown (Ohio) Sheet and Tube Co. The larger unit (44x50 in., 110 r.p.m., 700—4,000 hp. 480,000 lb.) will drive a 12-in. rod mill, and the smaller one (37x48 in., 110 r.p.m., 360,000 lb.) a 9-in. mill. These are reported to be the first American machines for this service, though similar engines up to 6,300-hp. continuous capacity have been so used in Germany. High economy under severe overloads is claimed to fit them particularly for this field.

The cylinder is a plain casting; all valve chambers and inlet passages are in bolted-on head castings. The valves are double-beat balanced poppets, with stems in lapped bushings, operated from a layshaft. Near the head bottoms are poppet reliefs which, on loss of vacuum and over-compression, automatically connect the clearance space with the steam space.

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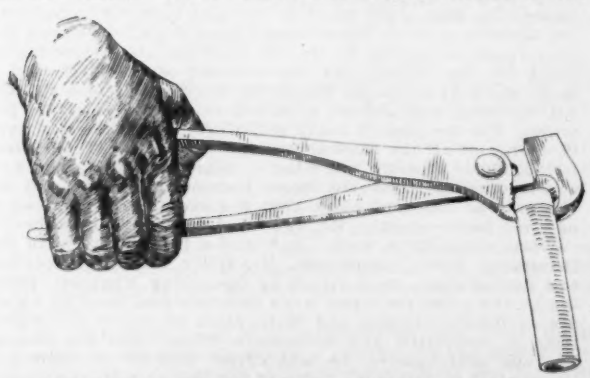
New Handy Wrench

The "Eagle-claw" wrench shown in the accompanying sketch is being made by the Mechanical Specialties Co., Peoples Gas Building, Chicago, as a general-utility tool for holding pieces of any regular or odd shape. The wrench consists of two



"EAGLE-CLAW" TURTLE-MOUTH WRENCH

pieces and a bolt and nut. The under jaw has a single prong and the upper jaw two prongs in addition to gas-pipe grips, which hold for turning both ways. For getting into difficult places one model is made with jaws at 45° to the handles. Three sizes are made; 7-, 10- and 13-in. The 7-in. holds pieces from 0 to 1 in., the 10-in. from 0 to 1¼, and the 13-in. from 0 to 1½ in. Prices range from 75c. to $1.25.